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A taxonomic survey of *Lotus* section *Pedrosia* (Leguminosae, Loteae)

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Summary: A taxonomic review of the section *Pedrosia* (excl. sect. *Rhyncholotus*) is presented. Members of the section occur in the Macaronesian Islands, north-western part of Africa and in the Mediterranean region. Centers of diversity are Canary Islands, Cape Verde, Madeira and Morocco. Twenty nine species of the section are recognized; their diagnostic characters are discussed and extensively illustrated. An identification key to species of the section is given as well as morphological descriptions of species and subspecies. Leaf morphology was found to be a particularly useful character in species discrimination. Many species are quite variable, and their identification is only possible using a suite of several characters. Furthermore, various morphological characters have different taxonomic weight in different regions (e.g. Cape Verde and Morocco). The following taxonomic decisions are adopted: (1) *Lotus azoricus* is synonymous with *L. argyrodes*; (2) *L. tenellus* is accepted as a species distinct from *L. glaucus*, with an area covering Tenerife and Gran Canaria; (3) all material examined from Hierro (Canary Islands) is identified as *L. sessilifolius*; (4) *L. hillebrandii* is treated as a subspecies of *L. campylocladus*; (5) *L. spartioides* is synonymous with *L. holosericus*. Representatives of the section *Pedrosia* from Lanzarote and Fuerteventura are closer to those from Madeira than to plants from other Canary Islands.

Keywords: Fabaceae, Leguminosae, Loteae, *Lotus*, *Pedrosia*, taxonomy, determination key, typification, comb. nov.

The genus *Lotus* includes agriculturally important plants such as *L. corniculatus*, and *L. pedunculatus*, as well as the model legume *L. japonicus* and ornamentals (e.g. *L. berthelotti* and *L. maculatus*). In recent times increased interest in the placement of *Lotus* and its species using molecular and morphological data has stimulated a closer examination of these genetic resources. Such studies need a sound taxonomic basis, however, *Lotus* is a taxonomically difficult genus (Gillett 1958; Heyn & Herrnstadt 1968; Kramina 1999a,b, 2006; Kramina & Sokoloff 2004). In particular, no detailed worldwide taxonomic study of the whole genus has been produced since Brand's (1898) monograph. However, in more recent times taxonomic and phylogentic studies of *Lotus* have been undertaken, for example, the phylogeny of *Lotus* has been studied by means of cladistic analyses based on morphological (Arambarri 2000) and molecular data (Allan et al. 2003, 2004; Degtjareva et al. 2006). In addition, Kirkbride (1999) published a worldwide list of *Lotus* species, while Kramina (1999b, 2006) published taxonomic studies of the *L. corniculatus* and *L. angustissimus* groups. Kramina (pers. comm.) is also preparing a monographic revision of the whole section *Lotus* which includes many agriculturally important species. Australian and Pacific *Lotus* species have been revised recently by Kramina & Sokoloff (2004). The present paper contributes to this ongoing taxonomic revision of the genus *Lotus* through the taxonomic survey of its section *Pedrosia*.

The section *Pedrosia,* which is sometimes accepted as a subgenus (Monod 1980; Mader & Podlech 1989; Kramina & Sokoloff 1999), includes about 30 species that are mostly perennial, some of which are rare or endangered, e.g. *Lotus kunkelii* and *L. mascaënsis* (Bramwell & Bramwell 2001). They cover a wide range of ecological conditions including littoral areas through to high-

Table 1: Geographic distribution of species in the *Lotus* sect. *Pedrosia.*

Distribution	1. *Lotus arenarius*	2. *Lotus marocanus*	3. *Lotus eriosolen*	4. *Lotus jolyi*	5. *Lotus tibesticus*	6. *Lotus assakensis*	7. *Lotus pseudocreticus*	8. *Lotus creticus*	9. *Lotus chazaliei*	10. *Lotus loweanus*	11. *Lotus macranthus*	12. *Lotus argyrodes*	13. *Lotus lancerottensis*	14. *Lotus glaucus*	15. *Lotus dumetorum*	16. *Lotus tenellus*	17. *Lotus sessilifolius*	18. *Lotus kunkelii*	19. *Lotus arinagensis*	20. *Lotus mascaënsis*	21. *Lotus spartioides*	22. *Lotus campylocladus*	23. *Lotus emeroides*	24. *Lotus callis-viridis*	25. *Lotus purpureus*	26. *Lotus brunneri*	27. *Lotus latifolius*	28. *Lotus arborescens*	29. *Lotus jacobaeus*
Azores																													
Santa Maria												+																	
São Miguel												+																	
Terceira								+																					
Graciosa																													
São Jorge												+																	
Pico												+																	
Faial																													
Flores																													
Corvo																													
Madeira Islands																													
Madeira											+	+	+	+															
Desertas												+		+															
Porto Santo										+	+	+		+															
Salvage Islands														+															
Canary Islands																													
Lanzarote													+																
Fuerteventura													+	+															
Gran Canaria																+		+	+		+			+					
Tenerife															+	+	+			+		+		+					
La Palma																						+							
La Gomera																	+						+						
El Hierro																	+												
Cape Verde																													
Santo Antão																									+		+		
São Nicolau																									+			+	
São Vicente																									+				
Sal																										+			
Boa Vista																									+	+			
Maio																										+			
Santiago																									+				+
Fogo																									+				+
Brava																									+				
Mainland Spain & Portugal	+							+																					
Mainland Africa	+	+	+	+	+	+	+	+	+																				
Remaining part of Mediterranean region								+																					

altitude pine forests and have a center of diversity in the Macaronesian Islands (tab. 1) of the Atlantic Ocean (i.e. Cape Verde, the Canaries, Salvage Islands, Madeira, and the Azores). The section is also present in mainland Africa and in the Mediterranean region. In Macaronesia there are only three sections (*Canaria*, *Rhyncholotus, Pedrosia*) of the tribe Loteae which includes 18 genera (Sokoloff 2003a) exhibiting considerable diversification. All three sections belong

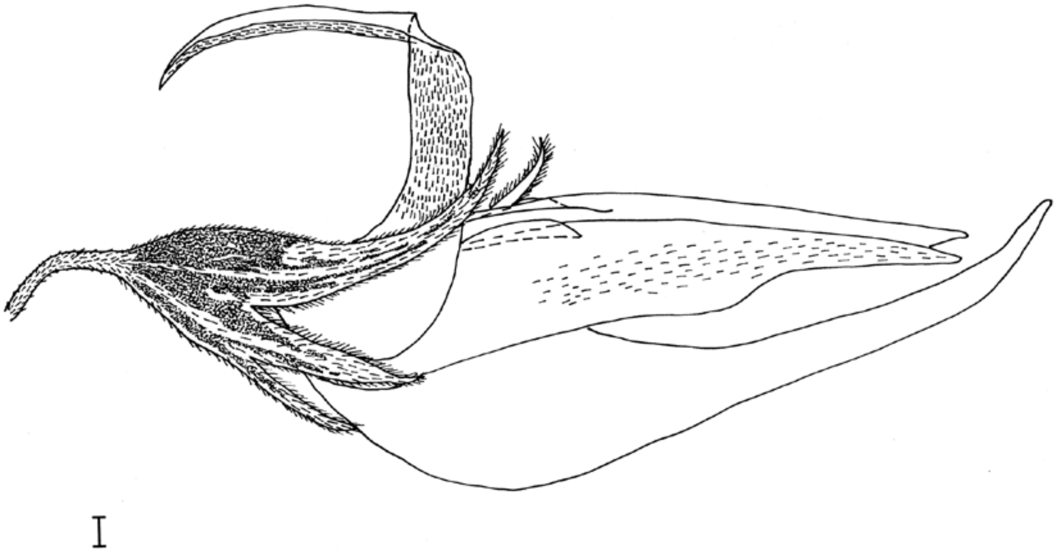

Figure 1: Flower of *Lotus berthelotii*. Scale bar = 1 mm.

to the genus *Lotus*, and the section *Pedrosia* is more diverse than the other two. The section *Canaria* is taxonomically isolated (Degtjareva et al. 2006) and was probably established in the Canaries before the radiation of *Pedrosia*. Other genera of the tribe do not have species endemic to the Macaronesian Islands, except for *Anthyllis*, which has a single and morphologically poorly differentiated endemic species on Madeira.

The most important diagnostic character of the section *Pedrosia* is the presence of a tooth on the ventral side of the stylodium (style) (Kramina & Sokoloff 1999). This feature is shared with the section *Rhyncholotus*, which species (*L. berthelotii* and its allies) are endemic to the Canary Islands. Previously this section was accepted as *Lotus* sect. *Heinekenia* (nom. illeg.) by Brand (1898), as a distinct genus *Heinekenia* by Christ (1888) and Kunkel (1974), as a subgenus *Rhyncholotus* by Monod (1980) and as section *Rhyncholotus* by Sokoloff (2003a). The section *Rhyncholotus* differs from the section *Pedrosia* as it includes plants that have a much more specialized corolla structure (fig. 1), that is linked with an adaptation to pollination by birds. Phylogenetic data clearly show monophyly of a clade comprising all studied members of *Pedrosia* and *Rhyncholotus* (Allan et al. 2004; Degtjareva et al. 2006). Relationships within this clade are not completely resolved, however, it seems that *Rhyncholotus* is embedded within the paraphyletic *Pedrosia*. Molecular data (nuclear ribosomal ITS) alone does not show monophyly of *Rhyncholotus* (Allan et al. 2004) while analyses of a combined data set (nrITS plus morphology) revealed its monophyly (Degtjareva et al. 2006). This could imply, that species of *Rhyncholotus* should be better placed into the broadly accepted section *Pedrosia*. We, however, do not pursue this amalgamation here as the phylogeny of the *Lotus berthelotii*-group is not well resolved and, in addition, it may be reasonable to keep some sections of *Lotus* paraphyletic (see Degtjareva et al. 2006 for discussion). These questions, however, are deserving of further study.

Another uncertainty in the section *Pedrosia* is the taxonomic position of *Lotus creticus*. This species was traditionally placed into section *Lotea* (Ball & Chrtkova-Žertova 1968). It was commonly believed, that *L. creticus,* as well as other species of the section *Lotea,* do not possess a tooth on the stylodium. However, Kramina & Sokoloff (1999) described the presence of a small tooth on the stylodium in some specimens of *L. creticus*. They suggested, that *L. creticus* can be transferred into the section (subgenus) *Pedrosia*. Valdés (2000) also described a tooth on the stylodium of *L. creticus,* but placed the species in the section *Lotea*. Molecular phylogenetic studies so far have not clarified these disagreements. For example, Allan et al. (2003, 2004) found *L. creticus* nested within the section *Lotea* while Degtjareva et al. (2006) found its placement within the *Pedrosia-Rhyncholotus* clade. Certainly more molecular phylogenetic data are needed to clarify the placement of *L. creticus*. In this study, we place *L. creticus* tentatively in the section *Pedrosia* as our new morphological observations confirm earlier findings by Kramina & Sokoloff (1999), that *L. creticus* is morphologically and ecologically similar to *L. pseudocreticus* of the section *Pedrosia*. Providing a more definitive assessment of the position of *L. creticus* will be the subject of further studies by the authors and their colleagues in Moscow.

Species-level taxonomy of the section *Pedrosia* is problematic. Since Brand's (1998) monographic study of the genus *Lotus* many new species have been described in this group. Monod (1980) produced a nomenclatural survey of all specific names published in the group, while Mader & Podlech (1989) and Brochmann et al. (1997) clarified taxonomic problems for *Pedrosia* species in Morocco and on Cape Verde, respectively. However, the most diverse groups of *Pedrosia* species are those inhabiting the Canaries and Madeira, and the morphology of these species has not been studied in its entirety, although several important works have been published. Davis (1971), Bramwell & Davis (1972) and Bramwell (1995) conducted detailed morphological and taxonomical analyses of species related to *L. glaucus* and *L. sessilifolius*. Allan et al. (2004) produced a phylogeny of Canarian species based on nrITS sequences and Oliva-Tejera et al. (2004) studied population genetics of representatives of *Pedrosia* which occur in Gran Canarian pine forests.

Prior to this publication no comprehensive worldwide study of *Pedrosia* or identification key for its species had been completed. Developing such a key is important for use in scientific centers studying the conservation, ecology and phylogenetics of such species, as correct identification of plant material is crucial in all these fields.

This study is based on two primary sources. The first is a living collection of *Pedrosia* species established from seeds collected in Africa and Macaronesia primarily by G. Sandral and collaborators in 2001–2004. Plants were established in a common garden at the University of Western Australia Field Station in Perth and examined over two years. The second source used were comprehensive collections of the herbaria BM, G, K, LE, LISU, M, MA, RNG and Z, which were examined and compared with the living collection.

Voucher herbarium specimens have been collected from almost all accessions cultivated for this study in Perth. One set of vouchers is deposited at MW and a second at K. Vouchers are cited in this paper along with other studied specimens, which are identified after the description of each species. Voucher numbers starting with the letters "SA" are referring to the accession numbers of germplasm, which are preserved as seeds for long term conservation at the South Australian Genetic Resource Center in Adelaide under the stewardship of curator Steve Hughes.

All drawings and photos in this paper are original and produced by Margarita Remizowa, except figs. 1, 3–6 which have been produced by Dmitry D. Sokoloff.

Morphological characters used in taxonomy of the section *Pedrosia*

As in other sections of *Lotus*, almost all taxonomically significant characters are variable within at least some species of the section *Pedrosia*. Only a combination of several characters can be used to identify the material and to assign specimens to particular species. That is why it is so difficult to produce a useful key for the identification of these species and why many species occur twice or even more than twice in the key presented here. It is important to note, that character overlapping not only occurs between closely related species, whose taxonomic separation could be questioned (e.g. *L. glaucus*, *L. tenellus* and *L. sessilifolius*), but also between less related species. For example, it was difficult to explain, how the Cape Verde species *L. purpureus* should be distinguished from clearly different species from Canary Islands.

It is important to point out, that plants cultivated in Perth are morphologically very similar to those taken from their natural habitat and conserved as herbarium samples. At least, we found no obvious deviations in taxonomically significant characters between these sources. The common garden ensured, that all observable characters were robust enough to be distinguished in a common environment. Also, our study of the living collection in Perth suggests that F1 interspecific hybrids are not frequent in natural populations in Canary Islands, Cape Verde and Madeira. Indeed all plants grown from the collected seeds showed similar morphology with regard to identification characters of that particular species.

We briefly discuss below some of the characters used in determining the taxonomy of *Pedrosia* (also see tab. 2).

Growth form. Among species of the section, only *L. arenarius* is an annual plant, although in some very rare cases individual plants did survive into the next season. The annual nature of *L. arenarius* observed in Perth agrees with observations made in the wild (Mader & Podlech 1989). This is an important taxonomic character, which distinguishes *L. arenarius* from the closely related *L. maroccanus*.

Among the perennial plants, herbs, half-shrubs (suffrutices) and dwarf shrubs can be recognized. Differences between these forms in *Pedrosia* are not stable and in most cases can only be used as a taxonomic tendency. It should be stressed that most "perennial" plants are in fact short lived (3 to 6 years). This is also true for shrubby plants, such as *L. arborescens* and *L. jacobaeus*. For example, these species can develop quite lignified trunks up to 2 cm thick; with second year buds located sometimes around 0.8 m above the ground. Such plants look like a long lived perennial, but may only be two years of age. Significant variation was found for longevity, with some plants dying after two seasons while others survived up to the fourth season, after which time the common garden was cleared for other purposes. Some other species, such as *L. emeroides*, develop long and often thick and lignified prostrate stems with second year buds close to the distal part of the main stem. These plants had densely branching shoot systems, and were also short-lived. Within the section *Pedrosia, L. eriosolen* seemed to be distinct in having adventitious roots (tab. 2) on prostrate stems. However, this did not increase its perenniality over that of *L. emeroides*, *L. arborescens* or *L. jacobaeus*, at least under the specific conditions of Perth.

Leaf morphology is probably the most significant set of characters in the taxonomy of the section (tab. 2). It is impressive, how more useful leaf characters are than floral characters in *Pedrosia*. As in most other *Lotus* species, the leaves of *Pedrosia* are (almost) sessile and have five

Table 2: Basic morphological character sets used in distinguishing species of *Lotus* sect. *Pedrosia* and chromosome numbers (2n). Seed morphology is described according to germplasm seed samples; data from herbarium specimens not counted. Chromosome numbers from Ortega (1976) and Grant (1995).

Features	1. *Lotus arenarius*	2. *Lotus maroccanus*	3. *Lotus eriosolen*	4. *Lotus jolyi*	5. *Lotus tibesticus*	6. *Lotus assakensis*	7. *Lotus pseudocreticus*	8. *Lotus creticus*	9. *Lotus chazaliei*	10. *Lotus loweanus*	11. *Lotus macranthus*	12. *Lotus agryrodes*	13. *Lotus lancerottensis*	14. *Lotus glaucus*	15. *Lotus dumetorum*	16. *Lotus tenellus*	17. *Lotus sessilifolius*	18. *Lotus kunkelii*	19. *Lotus arinagensis*	20. *Lotus mascaënsis*	21. *Lotus spartioides*	22. *Lotus campylocladus*	23. *Lotus emeroides*	24. *Lotus callis-viridis*	25. *Lotus purpureus*	26. *Lotus brunneri*	27. *Lotus latifolius*	28. *Lotus arborescens*	29. *Lotus jacobaeus*
1. Growth form																													
annual	+										(+)																		
biennial to perennial herb or semi-shrub		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+
dwarf shrub															+					+	+	+						+	+
2. Adventitious roots on prostrate stems																													
present		+	+																										
absent	+	+		+	+	?	?	+	?	?	+	+	+	+	+	+	+	?	+	?	+	+	+	+	?	+	+	+	+
3. Glandular stipules																													
present	+	+	+	+	+			+			+		(+)		(+)										+	+	+	+	+
not detectable	+					+	+	+	?	+	(+)	+	+	+	+	+	+	+	+	+	+	+	+	+			(+)	(+)	(+)
4. Leaflet number per leaf																													
always five (rarely six)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
five to three																										+			(+)
5. Leaf rachis length																													
no rachis (leaves palmate)								(+)	(+)					(+)			+	+	+	+									+
shorter than basal leaflets	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	(+)			+	+	+		(+)	(+)	+	+	+	+
about as long as basal leaflets	+											+	+									+	+	+	+	+	+		
longer than basal leaflets											+	(+)										+	+	(+)	+	+			
6. Basal (in pinnate leaves) or lateral (in palmate leaves) leaflet shape																													
unequally sided	+	+	+		+	+	+	+	+		+	+	+	+		(+)						(+)		(+)	(+)		+		
(almost) equally sided			+	+	+					+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 2 (continuation):

Features	**7. Maximum width of basal (lateral) leaflets**			**8. Distal leaflet shape**				**9. Stem hair density**		**10. Stem hair orientation**		**11. Stem hair morphology**		**12. Umbel peduncles on main shoots**	
	in the lower part of a leaflet	in the middle part of a leaflet	in the upper part of a leaflet	Orbicular	elliptic, obovate or triangular	narrowly elliptic or (linear) oblanceolate	Linear	dense (stem usually not visible between hairs)	not dense (stem surface is usually visible)	Appressed	(more or less) patent	Straight	Curved	present (triaxial plants)	typically absent (four-axial plants)
1. *Lotus arenarius*	+				+	+			+		+		+	+	
2. *Lotus maroccanus*	+				+	+			+		+	+	(+)	+	
3. *Lotus eriosolen*	+	+			+	+			+		+	+	+	+	
4. *Lotus jolyi*		+	+		+	+		(+)	+	+		+		+	
5. *Lotus tibesticus*	+	+	+		+	+		(+)	+	+	+	+	+	+	
6. *Lotus assakensis*	+				+	+		+			+	+		+	
7. *Lotus pseudocreticus*	+				+	+		+		+		+		+	
8. *Lotus creticus*	+				+	+		+		+		+		+	
9. *Lotus chazaliei*	+				+	+		+		+		+		+	
10. *Lotus loweanus*	+	(+)				+	+	+		+		+			
11. *Lotus macranthus*	+	+			+				+	+		+			+
12. *Lotus agryrodes*	+	+			+			+		+	+	+			+
13. *Lotus lancerottensis*	+				+	(+)		+	+	+	+	+	+	+	
14. *Lotus glaucus*	+	+	+		+	+		+	+	+		+		+	
15. *Lotus dumetorum*		+	+		+	+		+		+		+		+	
16. *Lotus tenellus*		+	+		+	+			+	+	+	+	+	+	
17. *Lotus sessilifolius*		+	+		+	+	+	+	+	+	+	+	+	+	
18. *Lotus kunkelii*		+	+	+	+			+			+	+		+	
19. *Lotus arinagensis*		+	+	(+)	+	+		+		+		+		+	
20. *Lotus mascaënsis*		+	+				+	+		+		+		+	
21. *Lotus spartioides*		+	+			+	+	+	+	+	+	+	(+)	+	
22. *Lotus campylocladus*	+	+	+		+	+			+	+	+	+	+	+	
23. *Lotus emeroides*	(+)	+	(+)	+	+				+	+	+	+		+	
24. *Lotus callis-viridis*	(+)	+	(+)		+				+		+		+	+	
25. *Lotus purpureus*	(+)	+	(+)	+	+				+	+	+	+		+	
26. *Lotus brunneri*	(+)	+	(+)		+	+	+		+	+		+		+	
27. *Lotus latifolius*	+	+			+	+		+	+	+	+	+		+	
28. *Lotus arborescens*	(+)	+	(+)		+	+			+	+	+	+		+	
29. *Lotus jacobaeus*		+	(+)			+	+		+	+	+	+		+	

Table 2 (continuation):

Features	1. *Lotus arenarius*	2. *Lotus maroccanus*	3. *Lotus eriosolen*	4. *Lotus jolyi*	5. *Lotus tibesticus*	6. *Lotus assakensis*	7. *Lotus pseudocreticus*	8. *Lotus creticus*	9. *Lotus chazaliei*	10. *Lotus loweanus*	11. *Lotus macranthus*	12. *Lotus agryrodes*	13. *Lotus lancerottensis*	14. *Lotus glaucus*	15. *Lotus dumetorum*	16. *Lotus tenellus*	17. *Lotus sessilifolius*	18. *Lotus kunkelii*	19. *Lotus arinagensis*	20. *Lotus mascaënsis*	21. *Lotus spartioides*	22. *Lotus campylocladus*	23. *Lotus emeroides*	24. *Lotus callis-viridis*	25. *Lotus purpureus*	26. *Lotus brunneri*	27. *Lotus latifolius*	28. *Lotus arborescens*	29. *Lotus jacobaeus*
13. Umbel peduncle length																													
≥ 4 times longer than subtending leaf	+	+	+	+		+	+	+	+				(+)		+	+	+	+	+	+	+	+	+	+	+				
less than 4 times longer than subtending leaf	+	+	+	+	+	+	+	+	+				+	+	+	+	+		+	+	+	+	+	+	+	+	+	(+)	(+)
as long as or shorter than subtending leaf											+	+		+														+	+
umbels almost sessile										+																			
14. Sterile bract length																													
longer than the calyx		+						+													(+)					+	+	+	+
shorter than or as long as the calyx	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15. Glandular flower-subtending bracts																													
Present	+	+	+	+	+	+	+	+	?					+	+	(+)	+	+		+	(+)	(+)	(+)		+	+	+	+	+
not detectable	+							+		+	+	+	+	+	(+)	+	+	+	+	+	+	+	+	+					
16. Typical flower number per umbel (rare exceptions not counted)																													
min.	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	3	1	1
max.	6	6	3	5	2	6	6	6	3	1	1	1	5	3	3	3	6	3	6	4	10	6	5	4	2	7	6	5	6
17. Typical calyx length, mm																													
min.	6	9	6	7	6	5	7	7	5	7	7	7	6	5	6	5	6	5	5	9	6	6	7	7	5	6	8	8	8
max.	11	11	11	10	9	9	8	9	8	11	9	15	8	8	7	7	8	7	6	12	9	9	9	9	7	7	11	10	11

Table 2 (continuation): **Features**	1. *Lotus arenarius*	2. *Lotus maroccanus*	3. *Lotus eriosolen*	4. *Lotus jolyi*	5. *Lotus tibesticus*	6. *Lotus assakensis*	7. *Lotus pseudocreticus*	8. *Lotus creticus*	9. *Lotus chazaliei*	10. *Lotus loweanus*	11. *Lotus macranthus*	12. *Lotus agryrodes*	13. *Lotus lancerottensis*	14. *Lotus glaucus*	15. *Lotus dumetorum*	16. *Lotus tenellus*	17. *Lotus sessilifolius*	18. *Lotus kunkelii*	19. *Lotus arinagensis*	20. *Lotus mascaënsis*	21. *Lotus spartioides*	22. *Lotus campylocladus*	23. *Lotus emeroides*	24. *Lotus callis-viridis*	25. *Lotus purpureus*	26. *Lotus brunneri*	27. *Lotus latifolius*	28. *Lotus arborescens*	29. *Lotus jacobaeus*
18. Upper calyx teeth length																													
shorter than the tube (incl. hypanthium)			+			+	+		+			+				(+)	+		+		+				+	+	+	+	+
as long as the tube (incl. hypanthium)		+	+			+	+	+	+			+	+	+	(+)	+	+				+	(+)	+		+	+	+	+	+
longer than the tube (incl. hypanthium)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+	+	+					
19. Hairs on standard																													
Present						(+)			+	+							+	+	+	+									
Absent	+	+	+	+	+	+	+	+			+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
20. Distal parts of wing petals																													
usually adhering together						(+)	+	+													+				+		+	+	+
not adhering together	+	+	+	+	+	+				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			
21. Keel tip																													
incurved upwards																									+	+		+	+
Straight	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		(+)	+	+	
22. Stylodium tooth																													
Present	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Absent								+		+																			
23. Hairs on stylodium tooth																													
Present																+		+											
Absent	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
24. Hairs on ovary/fruit																													
Absent	+	+			+										(+)								+	+				+	
along the ventral slit only					+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
along whole surface			+	+						+	+	+		(+)		(+)													

Table 2 (continuation): **Features**	1. *Lotus arenarius*	2. *Lotus maroccanus*	3. *Lotus eriosolen*	4. *Lotus jolyi*	5. *Lotus tibesticus*	6. *Lotus assakensis*	7. *Lotus pseudocreticus*	8. *Lotus creticus*	9. *Lotus chazaliei*	10. *Lotus loweanus*	11. *Lotus macranthus*	12. *Lotus agryrodes*	13. *Lotus lancerottensis*	14. *Lotus glaucus*	15. *Lotus dumetorum*	16. *Lotus tenellus*	17. *Lotus sessilifolius*	18. *Lotus kunkelii*	19. *Lotus arinagensis*	20. *Lotus mascaënsis*	21. *Lotus spartioides*	22. *Lotus campylocladus*	23. *Lotus emeroides*	24. *Lotus callis-viridis*	25. *Lotus purpureus*	26. *Lotus brunneri*	27. *Lotus latifolius*	28. *Lotus arborescens*	29. *Lotus jacobaeus*
25. Fruit morphology																													
strongly curved		+																											
straight short, with deep constrictions										+																			
straight, usually without deep constrictions	+		+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
26. Seed shape																													
ovate-round	+							+			+		+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
oblong-ovate											(+)	+																	
27. Seed surface sheen																													
semi-gloss	+							(+)																					
dull								+			+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+
28. Seed size																													
80% of seed < 1.1 mm																					+								+
80% of seed > 1.1 and < 1.3	+										+		+	+	+	+	+		+			+	(+)	+	+	+		+	
80% of seed > 1.3 mm								+				+											+				+		
29. Seed colour																													
yellow/green or yellow/brown	+							+			+			+	+	+			+		+		+						
brown/green or brown/yellow												+	+																
brown/tan																					(+)	+		+	+	+	+	+	+
30. Seed mottle																													
0 to <10%	+							+								+													
>10% and <40%													+	+		(+)							+						
40 to 60%											+	+			+				+		+	+		+			+	+	
>60%																						+			+	+			+
31. Chromosome number																													
2n = 14	+	+		+				+			+	+	+	+	+		+				+	+	+	+		+			+
2n = 28	(+)							(+)						(+)			(+)	+		+			(+)						

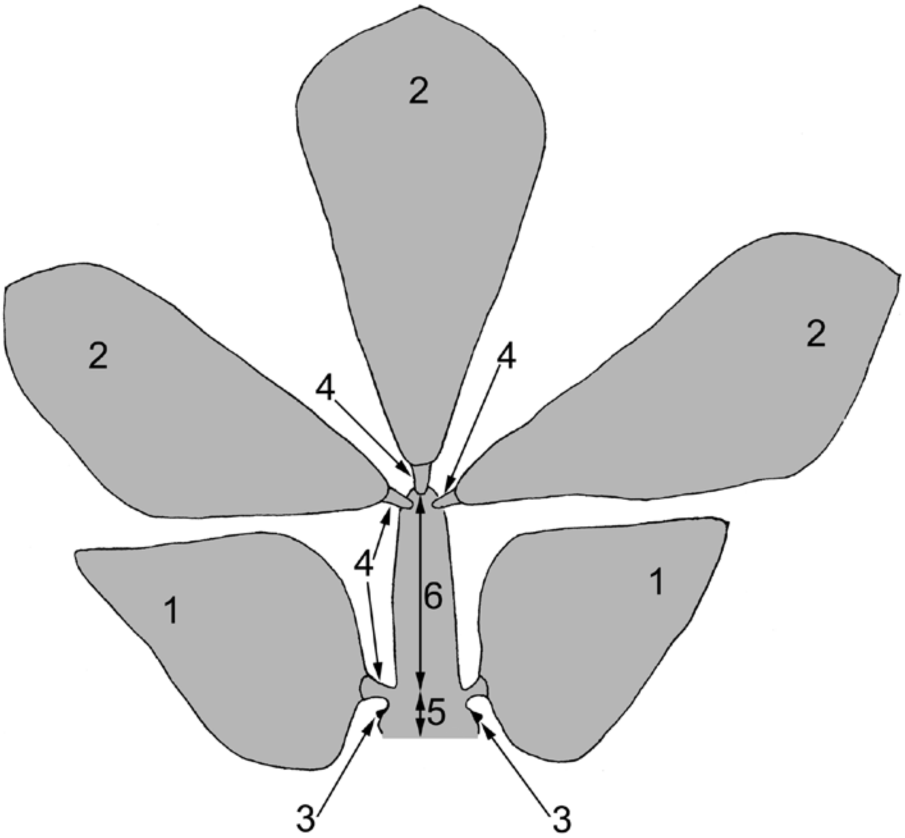

Figure 2: Descriptive terminology of *Lotus* leaf. 1 – basal leaflets (in this figure they are pronouncedly unequally sided and have maximum width in the lower part of a leaflet); 2 – distal leaflets (they are equally sided and have maximum width in the upper part of a leaflet); 3 – stipules; 4 – petiolules of leaflets; 5 – leaf petiole; 6 – leaf rachis.

leaflets (fig. 2). The stipules are either present as small dark glands or not detectable. Presence or absence of stipules is of taxonomic interest in *Pedrosia*, although the character is more variable here at the infraspecific level than in the previously investigated section *Heinekenia*[1] (Sokoloff 2001; Kramina & Sokoloff 2004). The leaf rachis is either elongate or suppressed while leaves are either pinnate or palmate, and these characters are of high taxonomic value. Basal and distal leaflet shape (fig. 2) is also of great taxonomic importance. In some species, basal leaflets are almost of the same shape as the three remaining (distal) leaflets of a leaf, with maximum width in the upper or middle part of a leaflet. In other species, the basal leaflets differ from distal ones in having their maximum width in the lower part of a leaflet, and they can be unequally sided. If we assemble together leaves of all members of the section *Pedrosia*, we would find a full continuum between leaves with five equal leaflets and those with basal leaflets remarkably different from distal ones. Each species occupies its own area in this variation range, and this is among the most important taxonomic features in the section, together with rachis length, and leaflet length to width ratio. As a tendency, even the leaf length is of taxonomic interest. Leaves of the Cape Verde species are generally longer than those of the Canarian species.

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[1] Regarding the use of the name *Heinekenia*, which cannot be used for the *Lotus berthelotii*-group (Brand 1898), see Kramina & Sokoloff (2003), and Degtjareva et al. (2006).

Indumentum of vegetative organs. Mader & Podlech (1989) demonstrated how useful indumentum characters are in the taxonomy of *Pedrosia* species from Morocco, and our data support this conclusion (tab. 2). For example, *L. assakensis* has very dense, short straight, patent hairs, *L. pseudocreticus*, *L. chazaliei* and *L. creticus* have very dense, short straight, appressed hairs, *L. arenarius* has moderately dense, curved, patent hairs of variable length, *L. maroccanus* typically has moderately dense, long straight, patent hairs. In contrast to Morocco, the indumentum characters are of no use in the group of Cape Verde species. Some authors (Coutinho 1914; Chevalier 1935) recognized narrowly-defined Cape Verde species using characters of indumentum (hairs appressed vs. patent). Brochmann et al. (1997) demonstrated that variation in hair type is merely infraspecific here and adopted a wider species concept. Our data agree with conclusions of Brochmann et al. (1997). Hair type (appressed vs. patent) is also variable in the material of *L. argyrodes* from Madeira archipelago, and hence this variation has no taxonomic value. The variation in hair morphology is even more pronounced in *L. lancerottensis*. Indumentum characters are important in the taxonomy of the *Lotus glaucus*-group and the *Lotus sessilifolius*-group; these issues are discussed in the systematic part of this paper.

Branching system and arrangement of umbels. Different types of branching system can be recognized among members of the section. They are described below. Note, virtually all nodes of all shoots develop axillary serial complexes rather than just a single axillary bud (see Velenovský 1910; Gulenkova 1974; Akulova et al. 2000). The main bud almost always develops a long shoot or a peduncle, while additional buds often remain dormant.

Type 1. In distal parts of shoots, the main bud of each axillary complex produces an umbel peduncle. This zone appears to be a floral unit (see Kusnetzova 1991), or main inflorescence. In the proximal part of the shoots, the main bud of each axillary complex usually develops a shoot, which repeats the structure of the main shoot (fig. 3). These lateral shoots can either develop flowers during the same season and hence are described as paracladia, or during the next season, described as innovation shoots. In fact, paracladia are not clearly differentiated from innovation shoots in most plants under investigation. Mostly there is no so-called inhibition zone on the main shoot. That often appears in representatives of other taxa between the proximal innovation shoots and the distal paracladia. Later in the season, additional axillary buds can develop paracladia or innovation shoots (for other legumes see Weberling 1989). If innovation shoots develop from additional buds within the main inflorescence, these innovation shoots sometimes produce a rather small shoot system. In these cases the plant should be regarded as a kind of shrub as almost the whole length of the main shoot is included in the perennial shoot system (the term “main inflorescence” or “floral unit” cannot be used). On the other hand, it often appears that some late small paracladia of a large synflorescence still continue their development during the second season (e.g. some plants of *L. jacobaeus* and *L. arborescens*). Then the whole larger shoot system dies.

Type 2. Main inflorescence (floral unit) is weakly differentiated. For example, some umbel peduncles could develop in the proximal part of the main shoot, whereas some others develop in the distal part of the main shoot (fig. 4). Main buds in axils of other nodes bear paracladia or innovation shoots. In some cases, main shoots have several zones of nodes bearing umbel peduncles (floral zones) which can be recognized. In rare cases, the main shoot could continue its growth for more than one season. This situation is close to monopodial type of shoot innovation.

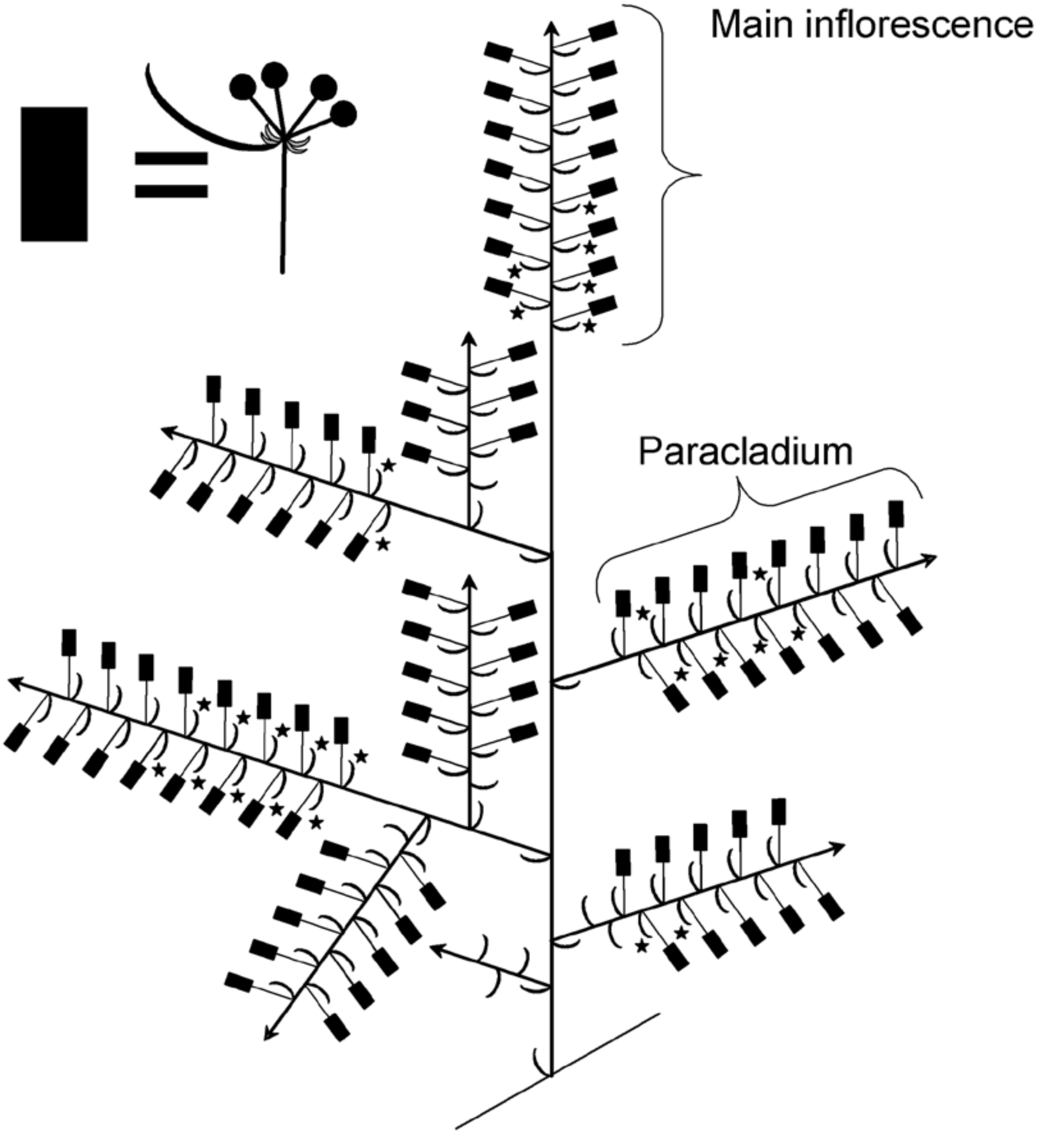

Figure 3: A scheme of shoot branching pattern and umbel arrangement in *Lotus latifolius* (*Sandral et al. 03-S78-239-S*). Black rectangles = umbels of flowers; each umbel with a large sterile bract and small glandular bracts subtending individual flowers. Arrowheads = growing shoot apices. Black arcs = foliage leaves. Many leaves of the plant possess two or several shoots in an axil. Such leaves are marked by stars. Only the main (first developing) axillary shoot is drawn here in axils of these leaves; shoots that develop from additional buds in the serial axillary complex are not shown. Note, that internode length is not to scale here; all internodes on a plant are of similar length.

In our observations we found that the differences between type 1 and type 2 have hardly taxonomic value in *Pedrosia*, although previously Sokoloff (2003b; also see Tikhomirov & Sokoloff 1996) found them to be taxonomically important in other groups of Loteae.

Type 3. Main shoots do not produce any umbel peduncle, and umbel peduncles are produced only in the proximal part of lateral shoots. This structure is typical for *L. macranthus* (fig. 5) and *L. argyrodes*. Although we found some exceptions, we believe that this feature is taxonomically

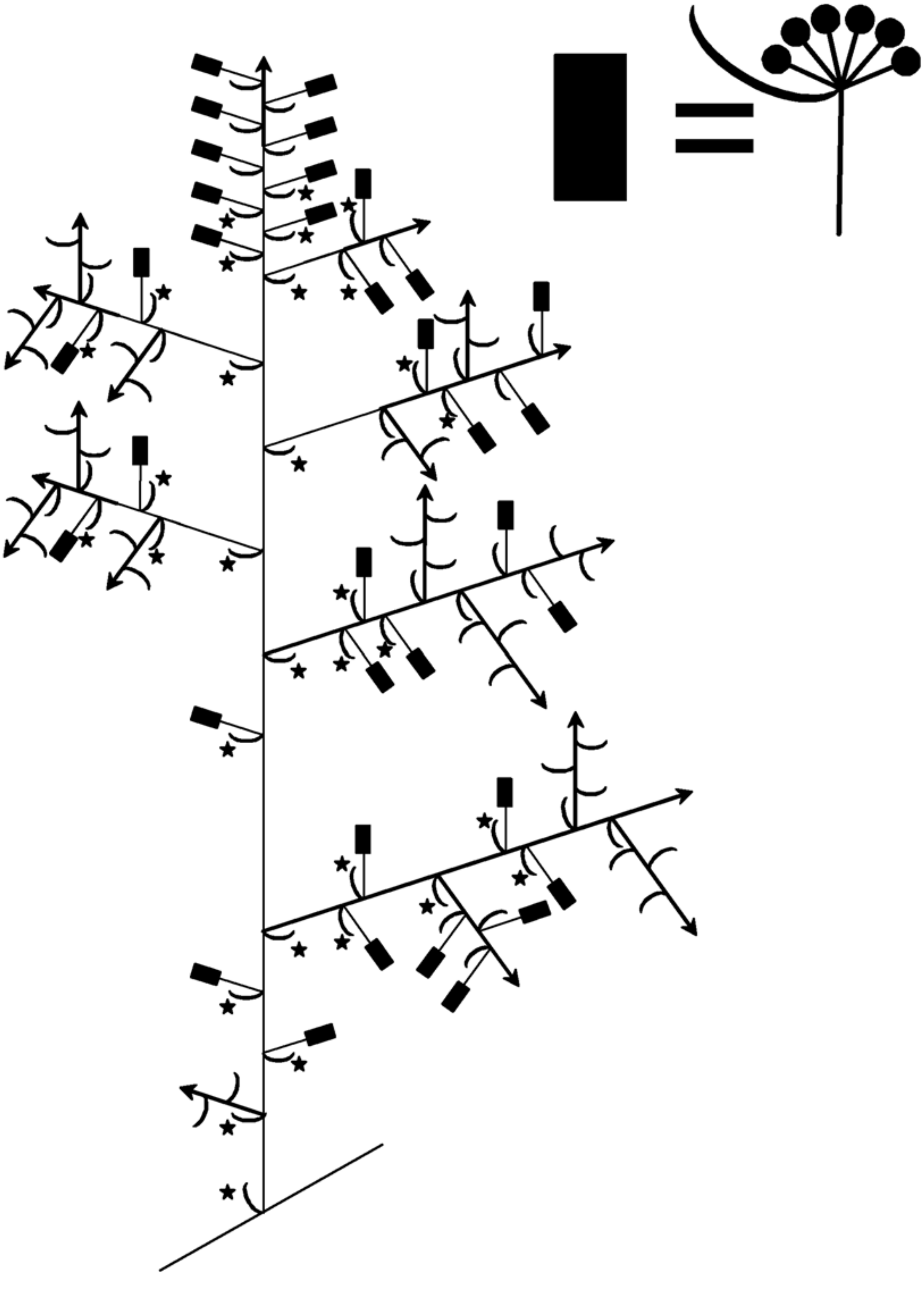

Figure 4: A scheme of shoot branching pattern and umbel arrangement in *Lotus arinagensis* (*Sandral et al. SA-40278*). Black rectangles = umbels of flowers; each umbel with a sterile bract at the base (flower-subtending bracts cannot be traced in this species). Other symbols as in fig. 3.

important. The differences between the typical structure (i.e. types 1 and 2) and the structure of *L. macranthus* and *L. argyrodes* can be described in terms of axiality (for terminology see Notov & Kusnetzova 2004). Most species of *Pedrosia* are three-axial plants, whereas *L. macranthus* and *L. argyrodes* are four-axial plants.

Studying serial axillary complexes in representatives of *Pedrosia* we found a well-marked regularity. If the main bud develops a paracladium, additional buds in the same node cannot develop an umbel peduncle. If the main bud develops an innovation shoot, additional buds can not develop an umbel peduncle or a paracladium (fig. 6).

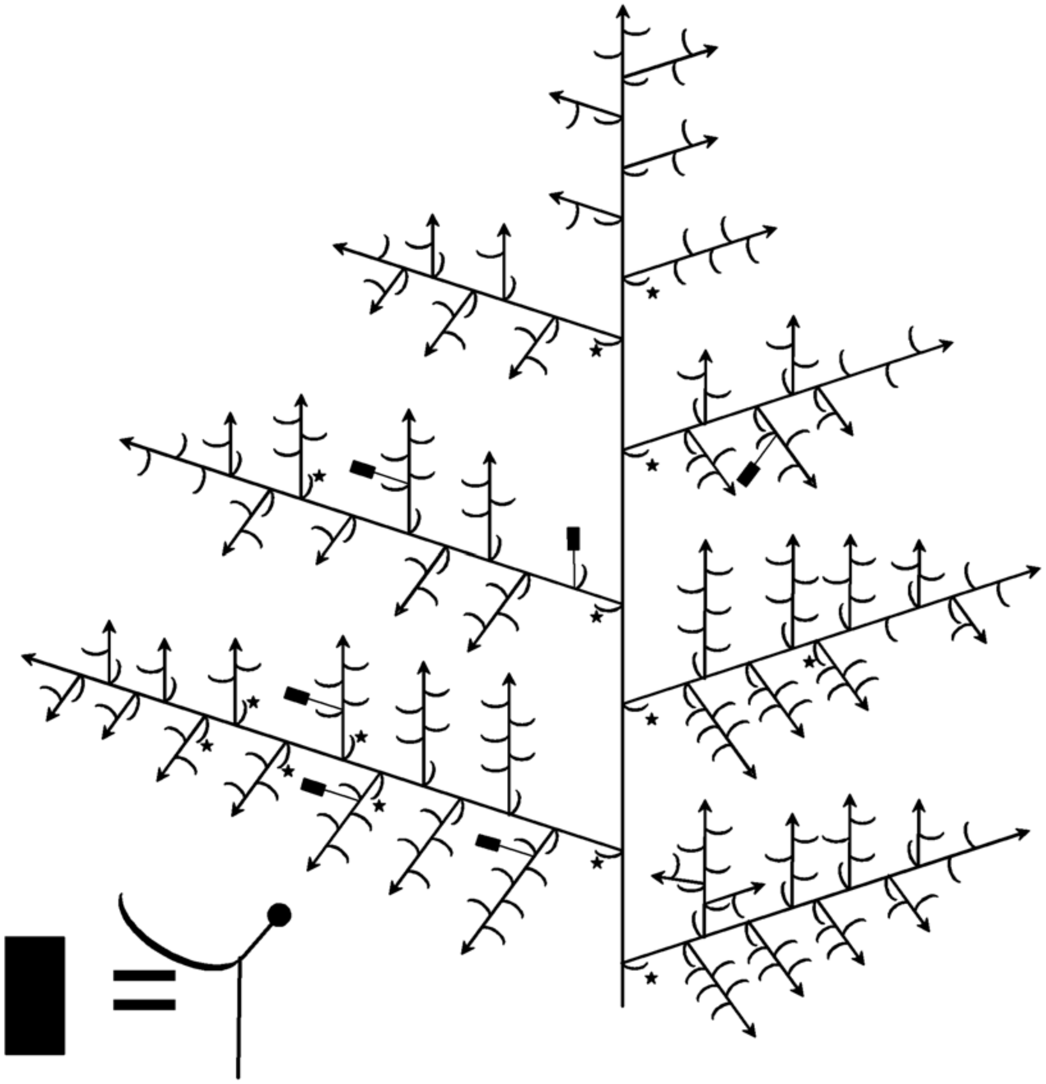

Figure 5: A scheme of shoot branching pattern and umbel arrangement in *Lotus macranthus* (*Sandral et al. SA-39120*). Black rectangles = one-flowered umbels; each umbel with a sterile bract at the base (flower-subtending bracts cannot be traced in this species). Other symbols as in fig. 3.

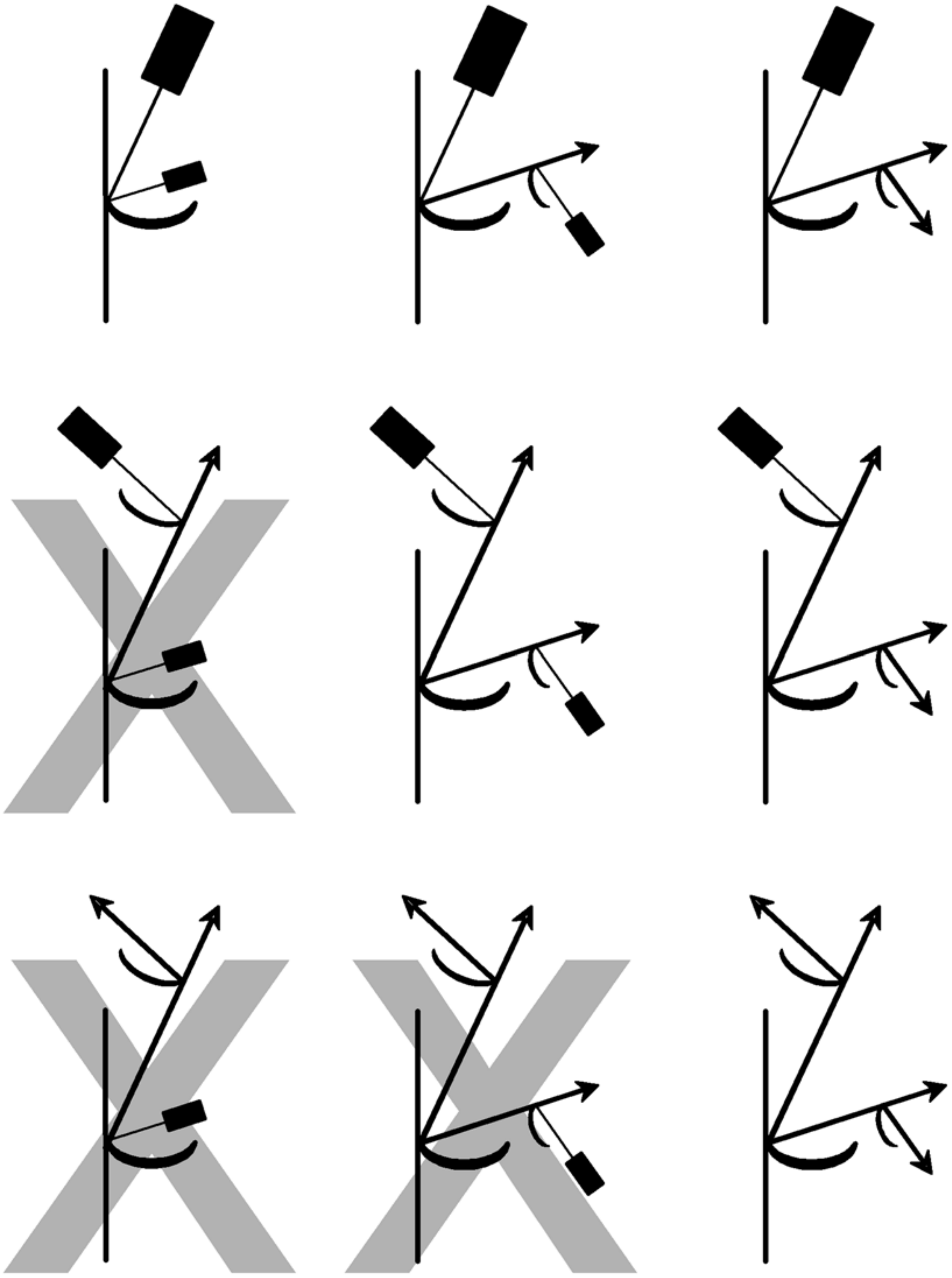

Figure 6: Theoretically possible combinations of shoot types developing from the main bud of an axillary serial complex and from the second bud in the axil of the same leaf. Combinations that we have not observed in our material are crossed out. Black rectangle = umbel of flowers; arrowhead = growing shoot apex that will not be terminated by an umbel (but may produce some lateral umbels in the future).

Whether additional buds are able or unable to produce umbel peduncles when the main bud produces an umbel peduncle, is in our opinion a taxonomically important tendency.

Umbel and peduncle. Many representatives of *Pedrosia* from the Azores, Madeira archipelago (*L. loweanus, L. macranthus, L. argyrodes*) and Salvage Islands (*L. glaucus* subsp. *salvagensis*) have short peduncles (not longer than their subtending leaves) and one-flowered umbels. *Lotus glaucus* subsp. *glaucus* (Madeira archipelago) approaches these taxa in having relatively short peduncles (tab. 2). This is an interesting geographical tendency, because *L. glaucus* seems to be taxonomically closer to species from Canary Islands than to other species from Madeira.

On Canary Islands and Cape Verde, the flower number per umbel varies from one to six, rarely more. No one species constantly has one-flowered umbels. Maximum flower number per umbel observed on a plant could be used as a taxonomic character. For example, members of the *Lotus glaucus*-group rarely have more than three flowers per umbel.

Flower-subtending bracts, if present, are small (not exceeding 0.5 mm), dark and glandular. Their presence or absence is taxonomically important, although this character – as many others in *Lotus* – shows certain infraspecific variation. All studied species possess a sterile bract at the top of the peduncle, just below the umbel. The sterile bract represents a foliage leaf with one to three (rarely four or five) leaflets. It has no flower in its axil. Brand (1898) widely used sterile bract length (longer or shorter than the calyx) for identification of *Lotus* species. The character is certainly more variable than Brand reported and cannot be used formally for identification. However, the sterile bract length is still important as a tendency. The Cape Verde species differ from the Canarian species in a tendency to have long sterile bracts.

Calyx. Calyx size can be used for identification of some species. For example, *L. purpureus* and *L. brunneri* differ from other Cape Verde species in shorter calyx and *L. mascaënsis* differs from its relatives in longer calyx (tab. 2). The monosymmetric (=zygomorphous) calyx is a trait, generally characterizing a large clade within the genus *Lotus*, which includes also the section *Pedrosia* (Degtjareva et al. 2006). This monosymmetry can be more or less pronounced in *Pedrosia*, but we do not think that these variations are of high taxonomic and diagnostic importance. Calyx teeth to tube ratio is important in taxonomy of *Pedrosia*, but considerable variation of this character should not be underestimated. For example, long calyx teeth (up to twice long than the tube) is a characteristic feature of *L. dumetorum*. However, this feature, although rare, can also be found in two taxonomically similar species, *L. tenellus* and *L. glaucus*.

Note, like in many other taxonomic publications on legumes, we include a short hypanthium in the length of the calyx and its tube. This should be considered when using numeric data presented in the descriptions.

Corolla. Our study showed that relative petal length (i.e. keel to wing to standard ratios) cannot be a useful character for identification of *Pedrosia* species. Petal morphology can be used in certain cases, although these characters are also variable and should be better considered as tendencies. Most Cape Verde representatives (except *L. brunneri*) have a remarkable incurved keel tip whereas species of *Pedrosia* from other regions have a straight keel tip (tab. 2). However, keel tip morphology is variable in the Cape Verde species *L. latifolius* and *L. purpureus*, although less variable in the latter example. This character has already been used in taxonomy of other groups of *Lotus*, where it was found to be more stable within species than in *Pedrosia* (Heyn 1970;

KRAMINA & SOKOLOFF 2004; KRAMINA 2006). Some members of *Pedrosia* have distal portions of wing petals united at anthesis. This feature is typical for *L. creticus* and *L. pseudocreticus* as well as for the Cape Verde species *L. arborescens*, *L. jacobaeus*, and *L. latifolius*, and it is observed less frequent in other members of *Pedrosia*. Curiously, wing petals adhering in their distal parts also characterize the section *Lotea* (KRAMINA & SOKOLOFF 1999), where *L. creticus* has often been placed, yet this character is not uncommon in *Pedrosia*. Many plants from Cape Verde have standard petals longitudinally folded at anthesis. However, this is only a tendency.

MADER & PODLECH (1989) and SOKOLOFF (2003b) believed that presence or absence of hairs on the outer surface of the standard is taxonomically important and stable at the species level. They described a hairy standard in *L. chazaliei* and *L. loweanus* only. Our present data show that this character is much more variable and can be found in some other taxa as well. We are grateful to T.E. Kramina who drew our attention to the variable nature of this character in *Pedrosia*.

Most members of *Pedrosia* have yellow or orange-yellow petals. They may develop red strips or be more or less brownish-red after anthesis. The keel tip can also be reddish. The difference between yellow and orange flowers is significant within the *L. glaucus*-group. When plants from many different accessions were cultivated under the same conditions in Perth, all accessions of *L. glaucus* from Madeira and Porto Santo (i.e. *L. glaucus* s.str. in our classification) were remarkably different from other accessions of this group in having orange flowers. A group of species from Madeira archipelago and the Azores (*L. macranthus, L. argyrodes,* and *L. loweanus*) has red to white flowers. In this case, not only the presence of red pigment is important, but also the absence or low quantity of yellow pigment. Red or brownish-red petals or parts of petals are also typical for the Cape Verde species (except *L. brunneri*). In Cape Verde species, red or brown pigments co-occur with yellow ones. The presence of red or brown pigments does not represent a trait that characterizes all individuals of certain species; some plants can have entirely yellow corolla, and proportions of such pigments differ from species to species (see BROCHMANN et al. 1997). It is interesting, how the character cannot be used to identify species here, but it is still important at a higher level to assist in distinguishing the Cape Verde species group. Two species from mainland Africa (*L. jolyi* and *L. eriosolen*) usually have a bicolored corolla (yellow plus red areas). This is the same phenomenon as in many plants from Cape Verde, but seeing the living plant of *L. eriosolen* the color of its flower cannot be mistaken with any Cape Verde specimen. We did not have *L. jolyi* in the common garden and cannot comment on its color.

Stylodium (which is also often called style). GILLETT (1959) demonstrated the usefulness of stylodium length for distinguishing between some closely related East African *Lotus* species. It has also been more recently used for taxonomic purposes in some other groups of *Lotus* (e.g. SOKOLOFF 2001; KRAMINA & SOKOLOFF 2004; KRAMINA 2006). While the presence of a tooth on the stylodium is a key character of *Pedrosia*, we did not find variation in style length to be useful between species of *Pedrosia*. As mentioned previously, the stylodium tooth is sometimes absent in *L. creticus* and if present, it is very short. Despite this, it is not possible to distinguish *L. creticus* from other species of this section by this character only. Interestingly, we observed some styles of *L. loweanus* without a tooth. The stylodium tooth is typically glabrous in *Pedrosia* species, although we found long and remarkable hairs on it in *L. kunkelii* and in one specimen of *L. tenellus*. More material of *L. kunkelii* should be studied to understand whether this feature is always present. However, the rare occurrence of this species in nature and its protection status may limit this research.

Ovary and fruit. The ovary and the fruit of most species possess hairs along the ventral slit only. This is a tendency characterizing a clade comprising sections *Rhyncholotus* and *Pedrosia*. Other sections of *Lotus* are characterized by completely glabrous ovaries and fruits (with very few exceptions: Gillett 1959; Degtjareva et al. 2006; Kramina 2006). Although hairs along the ventral slit are only a general tendency for *Pedrosia*, there is some variation within *Pedrosia*, which is also of taxonomic interest. Three species almost constantly have hairs covering the whole surface of ovaries and fruits (*L. eriosolen, L. jolyi,* and *L. loweanus*), whereas some species are variable for the presence or absence of hairs on fruit valves. Two mainland species (*L. arenarius* and *L. maroccanus*) do not possess hairs on the ovary and fruit, even along the ventral slit. This condition was rarely observed in few other species. However, the total absence of hairs in these two species is certainly significant (Mader & Podlech 1989).

Fruits of *L. maroccanus* differ from those of all other species in being strongly curved (although in a few cases the curvature is not well pronounced). Fruits of *L. loweanus* are very remarkable in being short and deeply constricted. However, irregular constrictions can be found from time to time in some other species as well as the shortness of fruits.

An overview of the section *Pedrosia*

1. Species endemic to or present in mainland Africa

Apart from the islands of the Atlantic Ocean, the section *Pedrosia* is most diverse in Morocco. All mainland *Pedrosia* species, except the problematic *L. tibesticus*, are either endemic to or present in Morocco (Mader & Podlech 1989). Three informal species groups can be recognized in the mainland.

The ***Lotus arenarius*-group** includes *L. arenarius* Brot., *L. maroccanus* Ball and *L. eriosolen* (Maire) Mader & Podlech. These species, in contrast to other mainland members of *Pedrosia*, share leaves with a well-developed rachis. This is only a tendency, however, and it is not possible to indicate a threshold length of the rachis or a ratio of the basal leaflet pair that allows technical identification of this species group. None of the three species in the *Lotus arenarius*-group have fruits with hairs confined to their ventral slit, a charateristic most common throughout the section *Pedrosia*. *L. arenarius* and *L. maroccanus* share completely glabrous fruits, whereas *L. eriosolen* has hairs covering all surfaces of ovary and fruit. *L. eriosolen* differs from *L. arenarius* and *L. maroccanus* also in the shape of lower leaflets of the leaf: the two halves of the leaflet are equal or approximately equal. In *L. arenarius* and *L. maroccanus* the halves of these lower leaflets are obviously unequal. The petal color in *L. eriosolen* is yellow with brownish red areas instead of entirely yellow. It is remarkable that *L. eriosolen* is able to produce adventitious roots on prostrate shoots. The species is restricted to the mountain regions of Morocco: central and eastern High Atlas and eastwards from it, and eastern Anti-Atlas (Mader & Podlech 1989), with the lowest collection from 850 m altitude. The species is morphologically well-defined, and it is surprising that its specific rank was established recently (Mader & Podlech 1989), although the material was present in many herbaria. *L. maroccanus* is also chiefly a mountain species endemic to Morocco, with vast majority of material collected at altitudes above 800 m in the southern part of Morocco. Although the ranges of these species overlap, *L. maroccanus* is more common to the southwest range of *L. eriosolen* (Mader & Podlech 1989). Morphologically, *L. maroccanus* is well-defined by distinctly curved fruits. When fruits are absent, it can be mistaken with *L. arenarius*, although plants of the latter species are mostly annual (not perennial), and stem hairs are typically not the same. The hairs are mostly straight in *L. maroccanus* and curved and of unequal length in *L. arenarius*, but this is a tendency only, and some plants show intermediate types of hairs. The collection *Jury et al. 14471* has stem hairs very similar to those in *L. arenarius*, but clearly curved fruits allow the identification of the specimen as *L. maroccanus*. Among numerous germplasm collections (or their voucher specimens at Kew) from Morocco available for this study, we found only one specimen of *L. maroccanus*. All other specimens labeled as *L. maroccanus* belong to *L. arenarius*. The latter species is the most common member of the section in Morocco, being especially typical for the Atlantic coast and adjacent regions (Mader & Podlech 1989). It is also present along the southern-most coastal part of Spain as well as in SW Portugal. Although *L. arenarius* has been collected at 1650 m, it mostly grows in lowlands, down to the sea level.

Another species group present in Morocco includes *L. creticus* L., *L. pseudocreticus* Maire, Weiller & Wilczek, *L. assakensis* Brand and *L. chazaliei* de Boissieu. We name this group ***Lotus assakensis*-group**. *L. creticus* is of course much more widespread than *L. assakensis*, but the term '*L. creticus*-group' has been used previously in quite a different sense (Heyn & Herrnstadt 1968). Thus we avoid using *L. creticus* to name this group. It differs from the *L. arenarius*-group in a short or absent leaf rachis, and in hairs on fruits and ovaries which are confined to their ventral slit. Stem and leaf hairs are typically short, straight and dense. *L. assakensis* differs from other species of its group in patent stem hairs. *L. assakensis* is confined to southern parts of the Atlantic coast in Morocco between Tarfaya and a locality to the north of Cap Rhir (Mader & Podlech 1989). In addition to appressed silky hairs on stems and leaves, *L. creticus* has a very short or hardly recognizable stylodium tooth (Kramina & Sokoloff 1999). This is also a chiefly coastal species, but with much wider distribution covering the Mediterranean region (up to Israel), Atlantic coasts of the Iberian Peninsula, Morocco as well as the Azores (Terceira) (Heyn & Herrnstadt 1968; Wiersema et al. 1990; Kramina & Sokoloff 1999). Previous references to the presences of *L. creticus* on La Gomera have been discounted as examination of the reported site, and an extensive survey of the island did not reveal the presence of *L. creticus*. This is the only member of *Pedrosia* distributed along the Mediterranean coast with the exception of *L. arenarius*, which is found in a few locations not far from the Strait of Gibraltar. This makes *L. arenarius* and *L. creticus* the only European members of *Pedrosia*. *L. creticus* is also the only species present on both, the mainland and on Atlantic islands. Interestingly, in culture at the University of Western Australia *L. creticus* showed the highest propensity to colonise beds, due to its high fecundity, extensive seed dispersal, and seed softening. This indicates an increased ability of *L. creticus* for colonising, which agrees with its present geographical distribution.

Lotus pseudocreticus is very similar to *L. creticus* in most morphological characters, but it differs in a well-developed stylodium tooth. In this character, *L. pseudocreticus* is close to *L. assakensis* and the rest of the *Pedrosia* species. Morphologically, *L. pseudocreticus* is intermediate between *L. assakensis* and *L. creticus*, and all three species are often confused in collections. A combination of two characters is needed for its identification, which includes a stylodium similar to *L. assakensis* and stem and leaf hairs similar to *L. creticus*. We do not know any other features characterizing *L. pseudocreticus* like that. The distribution of *L. pseudocreticus* along the Atlantic coast of Morocco covers the area, where *L. creticus* and *L. assakensis* overlap (*L. pseudocreticus* has also been reported from one locality in Western Sahara (Maire 1939) and one locality in Anti Atlas (Mader &

Podlech 1989), but we were unable to study these specimens and we cannot exclude a possibility of mixed labels). *L. pseudocreticus* and *L. creticus* are absent from Tarfaya province (SW Morocco) where *L. assakensis* is present. *L. pseudocreticus* also is absent from the northern part of the Atlantic coast of Morocco where *L. creticus* is present, but *L. assakensis* is absent. Examination of herbarium labels showed that all three species grow in similar ecological conditions and often side by side, usually on sand dunes near the seashore. In one herbarium specimen, two species (*L. assakensis* and *L. pseudocreticus*) are mounted together with the same label. It is possible that *L. pseudocreticus* is a hybrid between *L. assakensis* and *L. creticus*. Observations in nature, hybridization experiments as well as molecular studies should be undertaken to check such a hypothesis.

Lotus chazaliei differs from other mainland species in that the standard petal has some hairs on the outer surface (not glabrous) and it has relatively small flowers and leaves (Mader & Podlech 1989). *L. chazaliei* occupies coastal areas near the boundary between Western Sahara and Mauritania. The only one published specimen from the extreme southwest of Morocco (Mader & Podlech 1989) was not at our disposal. This locality is intriguing, as it implies a highly disjunctive distribution of the species. We found another specimen (which we identified as *L. assakensis*) from SW Morocco possessing a hairy standard. Stem hairs are patent in this specimen (like in *L. assakensis*) rather than appressed (like in *L. chazaliei*). The stem indumentum is less dense than that found in *L. assakensis* and *L. chazaliei*.

The third group of mainland *Pedrosia* includes *L. jolyi* and *L. tibesticus*. The ***Lotus jolyi*-group** is characterized by leaves with a basal leaflet pair exhibiting no strong differences in shape from distal leaflets. The leaf rachis is as short as in the *L. creticus*-group but the remarkable difference is the presence of conspicuous glandular stipules. The species *L. jolyi* shares with *L. eriosolen* fruits covered by hairs along the whole surface of the valves and often two-coloured petals. However, *L. jolyi* is not close to *L. eriosolen* and can easily be distinguished from it by a stem and leaf indumentum of short appressed hairs instead of long spreading hairs. *L. jolyi* is a Saharan species with a wide distribution covering Morocco, Algeria, Lybia, West Sahara, Mauritania and Chad. In Central Sahara, where it is the only member of *Pedrosia,* the species was collected mainly at elevations from 1400 to 3000 m, such as Hoggar, Tibesti and some other essentially volcanic uprisings. *L. tibesticus* Maire differs from *L. jolyi* in the fruits being either glabrous or with hairs along the ventral suture only. It also differs in stem hairs, which are patent or at least strongly curved (appressed in *L. jolyi*). The taxonomic status of *L. tibesticus* needs further investigations.

2. Species endemic to or present on Madeira archipelago (except *L. glaucus*)

Madeira archipelago has five species of the section *Pedrosia*, all confined to low elevations, often growing at sea level. Two of them are endemic (*L. macranthus* Lowe and *L. loweanus* Webb & Berthel.), one is shared with the Azores (*L. argyrodes* R.P. Murray), one with Canary Islands (*L. lancerottensis* Webb & Berthel.) and one with the Salvage Islands and probably (depending on taxonomic decisions) with Canary Islands (*L. glaucus* Ait.).

Lotus loweanus, which is endemic to the Island of Porto Santo, is probably the most remarkable species of the section. It differs from the rest of the section by a combination of such features as very short one-flowered peduncles (flowers appear to be solitary in axils of foliage leaves), blackish-purple to pink flowers, hairy outer surface of the standard, fruits densely pubescent along whole surface of valves and usually with one or several very deep constrictions between seeds. Some other members of *Pedrosia*, like *L. chazaliei*, have a hairy standard, however, their flowers are yellow and fruit valves are glabrous. Some other species of the section have densely hairy fruits, as *L. eriosolen*, but they are not constricted, and other features do not combine.

Lotus macranthus and *L. argyrodes* form a natural group. They share with *L. loweanus* stem and leaf indumentum with appressed hairs (except two of examined specimens of *L. argyrodes*), short one-flowered peduncles (although they are not as extremely short as in the latter species), non-yellow flowers (except some plants of *L. argyrodes*), and a tendency to have hairy fruit valves. Keeping in mind the similar distribution, all three species may be derived from a common ancestor. *L. macranthus* and *L. argyrodes* clearly differ from *L. loweanus* in having bigger flowers, much longer fruits, much longer leaf rachis, and much wider basal leaflets, which are of a different shape than the three terminal leaflets of a leaf. The Madeiran endemic *L. macranthus*, which is present in Porto Santo, Madeira Island, and Desertas (Press & Short 1994) has relatively sparse hairs, so that the foliage has no silvery appearance. *L. argyrodes*, in contrast, has dense silvery indumentum. It differs from *L. macranthus* also in a relatively shorter leaf rachis, in relatively wider fruits, and in some details of umbel arrangement. On the Madeira archipelago, *L. argyrodes* is known from Porto Santo, Madeira Island, and Desertas being rare in all islands (Press & Short 1994).

Ball (1968) described *L. azoricus* P.W. Ball as a species endemic to the Azores. This is one of two *Pedrosia* species growing on the archipelago. The second species is *L. creticus*. Both are confined to the coastal zone, but do not grow together. *L. creticus* is found in the Azores only in Terceira on sand dunes near Pria Da Vitoria, *L. azoricus* is absent from this island. *L. azoricus* is growing in volcanic rock and cliffs, such as those near Ponta do Castelete on Santa Maria. *L. creticus* and *L. azoricus* share dense silvery indumentum of stems and leaves as well as basal leaflets of a leaf with maximum width in their proximal part. *L. azoricus* can be easily distinguished from *L. creticus* in having one-flowered umbels with short peduncles and large non-yellow flowers. Before Ball (1968) described *L. azoricus* (a decision that was accepted by all subsequent taxonomic authorities), these plants from the Azores were identified either as *L. marcanthus* (Brand 1898) or sometimes as *L. argyrodes* (Murray 1897). Ball (1968) listed five characters to distinguish *L. azoricus* from *L. macranthus* and *L. argyrodes* (tab. 3).

Our observations confirm differences between *L. macranthus* and *L. azoricus* listed by Ball, i.e. indumentum type and legume width. In contrast, we were unable to prove differences between *L. azoricus* and *L. argyrodes*. For example, calyx teeth are sometimes longer than the tube in *L. argyrodes* (Porto Santo: *Lowe 3x*, 15 May 1855 [K]). This character is also variable in *L. macranthus*. Type material of *L. azoricus* (Santa Maria: *Hunt s.n.*, 1848 [K]) has flowers 20–22 mm long, but plants grown in Perth from seeds collected on Santa Maria in the Azores, have flowers 15–21 mm long. According to Press & Short (1994), the corolla of *L. argyrodes* is 13–25 mm long in Madeira. This character is also variable in *L. macranthus*, and our observations agree with Press & Short (1994), indicating flower length as 14–25 mm. The standard is clearly shorter than the keel in some specimens from Madeira (*Menezes s.n.*, Punta de S. Lourenço, Apr. 1915 [LISU]). According to our data, legume width is also more variable than indicated by Ball (1968). This is consistent with Press & Short (1994), who indicate legume width as 2.5–4.0 mm for *L. argyrodes*. We believe that these examples are sufficient to put *L. azoricus* into synonymy of *L. argyrodes*. Both, *L. macranthus* and *L. argyrodes*, are quite variable species, but it is not possible to distinguish any varieties or subspecies so far. The high variability of *L. argyrodes* is astonishing because only very few specimens were available for this study and the species is very rare. It is important to stress

Table 3: Characters and their character states used in the taxonomic determination of *Lotus macranthus*, *Lotus azoricus*, and *Lotus argyrodes*.

	Lotus macranthus	*Lotus azoricus*	*Lotus argyrodes*
Indumentum	sparsely hairy	densely hairy	densely hairy
Calyx teeth	slightly longer than tube	slightly longer than tube	slightly shorter than tube
Corolla	20–25 mm	20–25 mm	15–20 mm
Standard	shorter than the keel	shorter than the keel	as long as the keel
Legume width	2–2.5 mm	3–4 mm	2–3 mm

that *L. argyrodes* (incl. *L. azoricus*) is easily distinguishable from *L. macranthus*, although there is little doubt that they are closely related.

Lotus lancerottensis is a rare species on the Madeira archipelago and according to Press & Short (1994) it is found on maritime cliffs on the southern coast of Madeira Island. Only a few localities between Ribera Brava and Cabo Garajau are known and apparently it has not been seen recently. However, Sandral et al. were able to find this plant in Madeira in 2002 on the southern coast line as previously reported. The location was Larzareto not far from Funchal, which is about 11 km from the location reported in Press & Short (1994). Seeds have been collected from this population, and plants were grown in Perth. Apart from Madeira, *L. lancerottensis* is known from Lanzarote and Fuerteventura. Lanzarote and Fuerteventura have no other representatives of the section *Pedrosia*, except probably *L. glaucus* (that is also shared with Madeira). Interestingly, these two islands are not the closest islands to Madeira among the whole Canary archipelago; the closest are Tenerife and La Palma, which are of similar distance from Madeira. *L. lanzerottensis* is absent from the other Canary Islands despite Fuerteventura being more than five times closer to Gran Canaria than Lanzarote is to Madeira.

Lotus lancerottensis differs from the rest of species from Madeira in a combination of characters such as (1) basal leaflets of a leaf are always distinctly different from distal ones and with maximum width in their proximal part, usually unequally sided (these conditions are only rarely present in *L. glaucus*); (2) leaf rachis is well developed, almost as long as or slightly shorter than basal leaflets; (3) peduncles are longer than their subtending leaves with 1–5 yellow flowers. In all these characters *L. lancerottensis* resembles mainland species *L. arenarius* and *L. maroccanus*. It differs from these two species in having fruits with some hairs along the ventral suture (not glabrous); *L. maroccanus* also has curved fruits and *L. arenarius* is usually annual with wider wing petals.

Lotus lancerottensis is variable in Lanzarote and Fuerteventura, especially in terms of stem and leaf indumentum, which may be composed of short straight appressed hairs, or of strongly curved appressed hairs, or straight patent hairs. After examination of dry and living collections we believe, that this is a single variable species rather than a complex of two or three close species. Plants from Madeira are monomorphic, all showing short straight appressed hairs. Lowe (1862) described plants from Madeira under the name *Pedrosia neglecta* Lowe, but he compared this species only with *Pedrosia glauca* (Ait.) Lowe (=*L. glaucus*) and provided no distinction from *L. lancerottensis* s.str. It has also been demonstrated that plants from Madeira are tetraploid and plants from the Canaries are diploid (Grant 1995). More data on chromosome numbers of plants from Canaries are certainly needed and it will be important to establish whether all morphotypes with different hair morphology have the same ploidy level.

3. The *Lotus glaucus*-complex (Madeira archipelago, Salvage Islands, Canary Islands)

The *Lotus glaucus*-complex differs from the above discussed taxa in leaf, inflorescence and flower structure. Basal leaflets are usually of almost the same shape as distal ones, leaf rachis is present, but short (typically shorter than half a length of basal leaflets); peduncles are usually 1–3-flowered, and flowers are yellow to orange.

Lotus glaucus was first described from Madeira Island. Traditionally, this species is treated in a wide sense, so that it includes plants from Madeira as well as those from the Canaries (Tenerife, Gran Canaria and possibly Fuerteventura) and Salvage Islands (e.g. Davis 1971; Bramwell & Bramwell 2001; Kirkbride 1999). A closely related species from Tenerife (Canary Islands) is *L. dumetorum* R.P. Murray. Although all recent authors agree that this taxon is close to *L. glaucus*, they typically accept *L. dumetorum* as a distinct species. Our study shows, however, that differences between *L. dumetorum* and *L. glaucus* are of approximately the same significance as those between different morphotypes within *L. glaucus*. Thus, it is logical either to put *L. dumetorum* into synonymy of *L. glaucus* or to subdivide *L. glaucus* into more natural units. It is not easy to determine, which of the two options is best. At this stage we prefer to accept three species in the *Lotus glaucus*-group (including *L. dumetorum*), but it is equally possible to accept *L. glaucus* in a wide sense with three (or even more) subspecies. We accept *L. glaucus* s.str. as a species endemic to Madeira, Salvage Islands and probably Fuerteventura (Canary Islands). The most important diagnostic feature of this species is the color of the corolla. Flowers of *L. glaucus* from Madeira and Salvage Islands are orange-yellow, whereas plants from Tenerife and Gran Canaria (Canaries) are yellow-flowered. There is probably an overlapping in variation of this character between the Canaries and Madeira, as Lowe (1862) reported eight yellow-flowered individuals from the island of Porto Santo in Madeira. After extensive collections and examination we did not find such plants in the living collection established in Perth. Lowe's plants are still available as dried herbarium specimens; although petal color cannot be identified in these samples, they are the same as other collections from Porto Santo in all measured characters and cannot be confused with the material from the Canaries (the same conclusion was made by Lowe l.c.). All plants of *L. glaucus* s.str. have appressed indumentum with straight short hairs. The material from Salvage Islands has mostly shorter peduncles than material from Madeira. It is also often (not always) unusual in other characters such as leaves and rachis, which are bigger and longer than in typical *L. glaucus*. Basal leaflets of Salvage Island material are found to be often of a considerably different shape than terminal leaflets of a leaf. We accept the material from Salvage Islands as a subspecies of *L. glaucus*, although further investigation is clearly needed.

On the Canaries, we accept two main taxa, namely *L. dumetorum*, which occurs in mid-elevations of Tenerife, and *L. tenellus*, which occurs in the coastal zone of Tenerife and Gran Canaria. *L. dumetorum* differs in the growth habit (a shrublet), as well as in the presence of a dense silvery stem indumentum of appressed straight hairs. Long calyx teeth are also characteristic for this species. Hairs of *L. tenellus* are not silvery in general appearance; they are either curved and patent or straight and appressed, and it does not have a shrubby growth form. *L. glaucus* s.l. was also reported from La Gomera, but we are unable to confirm the presence of any member of the *L. glaucus*-complex on this island.

4. Species endemic to Canary Islands

Three informal groups of *Pedrosia* species endemic to the Canaries can be recognized, namely the *Lotus sessilifolius*-group, the *Lotus campylocladus*-group and the *Lotus emeroides*-group. The section

Rhyncholotus, which is closely related to *Pedrosia*, forms the fourth group of endemic species. The endemic species are confined to central and western part of the Canaries (Gran Canaria, Tenerife, Gomera, La Palma and Hierro).

The ***Lotus sessilifolius*-group** includes *L. sessilifolius* DC., *L. mascaënsis* Burchard*, L. kunkelii* (Esteve) Bramwell & D.H. Davis and *L. arinagensis* Bramwell. The core of this group forms *L. sessilifolius*, which is frequent in coastal regions of Tenerife from sea-level up to 150 m (Bramwell & Bramwell 1974). *L. sessilifolius* is often confused with members of the *L. glaucus* complex, especially with *L. tenellus,* which is also common in the coastal region of Tenerife. Two basic features allow technical identification of *L. sessilifolius*, namely palmate leaves with suppressed rachis or rarely with a very short rachis up to 1 mm long and umbels with 1–6 flowers, at least some umbels on a plant with more than three flowers. In the *L. glaucus* group, the rachis is short but present, and the umbels are typically 1–2(3)-flowered. *L. sessilifolius* is variable in terms of stem, leaf and calyx indumentum, which can be composed of either appressed or patent hairs. Similar variation is present in the group of *L. glaucus*. Many plants of *L. sessilifolius* from Tenerife combine different hair types in different parts of the same plant, a tendency that was not observed in the *L. glaucus*-group. Many (not all) plants of *L. sessilifolius* have straight and patent hairs on the calyx, whereas in the *L. glaucus*-group the calyx bears either appressed straight hairs or more or less curved hairs (e.g. *L. tenellus*). There are also differences in growth type and overall habit between the *Lotus glaucus*-group and *L. sessilifolius*. However, it is very difficult to formulate these differences and use them in a key. In the key by Davis (1971), *L. sessilifolius* is said to be perennial with woody stock while *L. glaucus* s.l. is usually biennial with stock semi-woody and stems generally slender, procumbent. Our observations in culture show that *L. sessilifolius* does not represent a considerably more long-living plant. In the key by Bramwell & Bramwell (2001), *L. sessilifolius* is distinguished from the *L. glaucus*-group by narrow linear leaflets. However, narrow leaflets are present also in some members of the *L. glaucus*-group. Oblanceolate and even obovate leaflets are present in some specimens of *L. sessilifolius* from Tenerife.

It is possible that some specimens from Tenerife represent hybrids between *L. sessilifolius* and *L. tenellus*, because they combine features of the two species: they have a distinct rachis and many-flowered umbels with long patent hairs on the calyx. Such plants are probably not frequent, because they are rare in collections.

All *Pedrosia* material from Hierro Island available for this study belongs, in our opinion, to *L. sessilifolius*. This material previously has been often classified as *L. glaucus* (Pitard & Proust 1908; Davis 1971; Bramwell & Bramwell 2001). It shares with the *L. glaucus*-complex 1–4-flowered umbels. In other respects, however, plants from Hierro are very similar to *L.sessilifolius* from Tenerife. They have palmate leaves (without a rachis). All plants from Hierro have patent hairs that are either straight or curved, and their density varies from specimen to specimen. The hair type is consistent across a specimen, in contrast to many specimens of *L. sessilifolius* from Tenerife. Some specimens from Hierro have hairs on the outer surface of the standard while others do not have these hairs. This condition has not been observed, neither in *L. sessilifolius* from Tenerife nor in the *L. glaucus*-complex, but is present in some members of the *L. sessilifolius*-complex such as *L. mascaënsis, L. arinagensis* and *L. kunkelii.*

We accept plants from Hierro as a subspecies, *L. sessilifolius* subsp. *villosissimus* (Pitard) Sandral & D. D. Sokoloff, because the Hierro material generally differs from the Tenerife material, but some plants from Tenerife are similar to those from Hierro and cannot be identified without referring to a label.

BRAMWELL & BRAMWELL (1974) recognized a variety of *L. sessilifolius* with filiform leaflets, var. *pentaphyllus* (Link) D.H.Davis (unpublished name), which grows along the southern coast of Tenerife. They reported this variety also from Hierro (Golfo region). We were unable to find such plants in Hierro. *L. sessilifolius* subsp. *villosissimus* is common in the Golfo region and seemingly represents the only member of *Pedrosia* on the Hierro Island. In the second edition of their book, BRAMWELL & BRAMWELL (2001) do not report var. *pentaphyllus* from Hierro.

Lotus kunkelii and *L. arinagensis* are local endemics inhabiting limited areas in the coastal zone of Gran Canaria. They can be easily distinguished from each other, because *L. kunkelii* has a dense indumentum of short straight patent hairs, whereas *L. arinagensis* has a dense appressed indumentum. Distinguishing these two species from *L. sessilifolius* is not an easy task. Both, *L. kunkelii* and *L. arinagensis*, have small and wide (sometimes even rounded) leaflets, but this is a tendency only, and leaflet shape variability in *L. sessilifolius* overlaps with that of the species from Gran Canaria. Leaflets of *L. kunkelii* are also quite succulent and its indumentum is denser than that of any other member of the *L. sessilifolius*-complex. *L. kunkelii* also resembles *L. assakensis* (from Morocco) in compact habit, dense indumentum, and occurrence along the sea shore. However, it can be easily distinguished from *L. assakensis* by leaves with all five leaflets of similar shape. *L. arinagensis* differs from *L. sessilifolius* in smaller flowers with a calyx 5–6 mm long compared to 7–8(9) mm in *L. sessilifolius*. *L. arinagensis* also resembles *L. chazaliei* from mainland Africa: they both have small leaves, dense silvery indumentum, and usual presence of some hairs on the outer surface of the standard. However, it can be distinguished from *L. chazaliei* by umbels, which have more flowers (e.g. some umbels on a plant with four and more flowers) and by larger floral parts (e.g. wings and stylodium).

Lotus mascaënsis Burchard is a very rare species endemic to Valle de Masca on the west side of Tenerife. According to BRAMWELL & BRAMWELL (2001), the species is locally common here at altitudes of 400–600 m. The first author of the present paper spent several days trying to find *L. mascaënsis* in Valle de Masca, but without result. It might be possible that the species is extinct in the wild. The best technical diagnostic feature of *L. mascaënsis* is a long calyx (9–10 mm), which is longer than in any other member of the *L. sessilifolius*-complex. Besides, leaves of *L. mascaënsis* often (not always) possess a rachis exceeding 1 mm. This is important because all other members of the group have palmate leaves. The close relationship of *L. mascaënsis* with the material of *L. sessilifolius* from Tenerife is, however, obvious especially from characteristic calyx indumentum and narrow linear leaflets. *L. mascaënsis* also resembles *L. spartioides* Webb & Berthel. from Gran Canaria, but leaves are never palmate and the calyx is shorter in the latter species. The similarity with *L. spartioides* is of interest, because *L. spartioides* is a species restricted to high elevations, and *L. mascaënsis* occurs in higher elevations than *L. sessilifolius* and its allies from Gran Canaria.

The ***Lotus berthelotii*-group** (=section *Rhyncholotus*) is probably closest to the *L. sessilifolius*-group. It shares long linear or filiform leaflets with *L. mascaënsis* and some specimens of *L. sessilifolius*. Leaves of *L. berthelotii* and its allies are palmate, which is also typical for the *L. sessilifolius*-group. Hairy petals (wings and standard) are characteristic for the *L. berthelotii*-group. The standard is also hairy in some representatives of the *L. sessilifolius*-group, and this feature has not been observed so far in other Canarian species of *Pedrosia*. Finally, *L. mascaënsis* approaches the *L. berthelotii*-group in having large flowers.

An alternative hypothesis could be, that the *L. berthelotii*-group is related to chiefly red-flowered species from Madeira and the Azores (*L. loweanus*, *L. macranthus, L. argyrodes*). Indeed, *L. berthelotii* has red flowers, a character that is not present in any species of *Pedrosia* from Canary Islands. The species from Madeira and the Azores share short peduncles with the *L. berthelotii*-group. *L. loweanus* has a hairy standard and linear leaflets, whereas *L. macranthus* and *L. argyrodes* have large flowers with a long keel that approaches the keel of *L. berthelotii*. In our opinion, the first hypothesis on relationships of the *L. berthelotii*-group is more realistic, although the alternative can not be ruled out.

The ***Lotus campylocladus*-group** includes *L. spartioides* from Gran Canaria, *L. campylocladus* Webb & Berthel. from Tenerife and *L. hillebrandii* Christ from La Palma. All three taxa are typical for montane regions, often growing in pine forests (Bramwell & Bramwell 1974). Morphologically, the group differs from the *L. sessilifolius*-group in leaves with a distinct rachis (also present in *L. mascaënsis*, which has a longer calyx) and from the *L. glaucus*-group in peduncles with generally more flowers (1–3 in *L. glaucus*-group and up to 6(10) in *L. campylocladus*-group, but this is a tendency and cannot be used in a key). Most significant is the ecological difference, as both, *L. glaucus*- and *L. sessilifolius*-groups, are restricted to the coastal zone (except *L. mascaënsis*). Representatives of the *L. campylocladus*-group also have a tendency to grow as dwarf shrubs (most prominent in *L. spartioides*).

Lotus spartioides has all leaflets typically linear with parallel margins and indumentum of straight hairs. It is a variable species in terms of indumentum density and hair direction (appressed or almost spreading) as well as other characters, and some authors thus accepted more than one montane *Pedrosia* species in Gran Canaria (Webb & Berthelot 1848; Bramwell & Bramwell 1974, 2001). Oliva-Tejera et al. (2004) studied variability of *L. spartioides* s.l. by means of molecular markers; their data support wide treatment of the species rather than segregation of *L. holosericus* Webb & Berthel. Our observations agree with this conclusion. We had difficulties with the identification of some specimens from Gran Canaria as *L. spartioides* or *L. tenellus*. A similar phenomenon has been previously mentioned by Bornmüller (1903).

Lotus hillebrandii has basal leaflets which differ in shape from distal ones. At least some leaves on a plant of *L. hillebrandii* have basal leaflets with maximium width in their proximal part. Leaflets of *L. hillebrandii* are also wider than in *L. spartioides*, distal ones are obovate or oblanceolate.

Lotus campylocladus is morphologically intermediate between *L. spartioides* and *L. hillebrandii*, which is not surprising, because Tenerife Island lies between Gran Canaria and La Palma. Leaflets of *L. campylocladus* are generally wider than in *L. spartioides*, but variation of leaflet shape overlap to some extent. The most useful technical distinction is hair type (usually curved in *L. campylocladus* and straight in *L. spartioides*). Two basal leaflets of *L. campylocladus* only slightly differ in shape from three terminal leaflets of a leaf, whereas this difference is mostly obvious in *L. hillebrandii*. This character typically allows distinguishing plants from Tenerife (*L. campylocladus*) and plants from La Palma (*L. hillebrandii*). However, certain experience is needed to use it, and difference in leaflet shape is difficult to describe in a key. Bramwell & Bramwell (1974, 2001) stated that leaflets are 2–4 mm in *L. hillebrandii* and 4–10 mm in *L. campylocladus*. According to our data, distal leaflets of a leaf are 1–9 mm long in *L. campylocladus* and 3–25 mm in *L. hillebrandii*. In general, differences between *L. campylocladus* and *L. spartioides* are more pronounced than those from *L. hillebrandii*, and it is possible to accept *L. hillebrandii* as a distinct species or as a subspecies of *L. campylocladus*. After studying ample material we decided that it is better to accept it as a subspecies. Thus, we propose a new combination, *L. campylocladus* subsp. *hillebrandii* (Christ) Sandral & Sokoloff.

Some specimens of *L. campylocladus* subsp. *hillebrandii* resemble *L. lancerottensis* in leaf morphology, although *L. lancerottensis* has a more pronounced difference between basal and terminal leaflet shape. Considering geographical distribution and ecological preferences of *L. lancerottensis*, it seems that its resemblance with *L. campylocladus* subsp. *hillebrandii* is most likely due to parallel evolution.

The ***Lotus emeroides*-group** includes *L. emeroides* R.P. Murray and *L. callis-viridis* Bramwell & D.H. Davis. These species share leaves with a long rachis (slightly shorter to longer than basal leaflets) as well as tendencies to have orbicular basal leaflets and long calyx teeth. *L. emeroides* is locally most frequent in the northern cliffs of La Gomera (Bramwell & Bramwell 1974), up to 600 m. *L. callis-viridis* is a rare species described from the coastal region of Gran Canaria near Andén Verde. It was considered to be a local endemic of this place. We also found a very similar specimen collected near Buenavista in Tenerife (*Asplund 565*, 27 Mar. 1933 [G]). It is strange for such a rare species to have such a disjunctive range. *L. callis-viridis* differs from *L. emeroides* in a combination of such characters as very long calyx teeth (at least twice longer than the tube), leaves, pedicels, and calyx with long spreading and incurved hairs and hairs on the calyx only along the veins. *L. emeroides* is variable in terms of indumentum and calyx teeth length. Some plants of *L. emeroides* have long calyx teeth, but hairs are not the same as in *L. callis-viridis*. In addition, some plants of *L. emeroides* have a glabous calyx between the veins, but such plants do not fit *L. callis-viridis* in other characters. Bramwell & Bramwell (1974) stated that *L. emeroides* differs from *L. callis-viridis* in smaller flowers and petals usually purple-tipped. We were unable to confirm these observations in the living collection grown in Perth, as plants produced yellow petals only.

5. Species endemic to Cape Verde Islands

Cape Verde endemics have been recently studied in detail by Brochmann et al. (1997). That work reduced considerably the number of recognized species by use of broad species concept. Brochmann et al. (1997) accepted only five species of *Pedrosia* in Cape Verde, all endemic to the archipelago. This study confirmed taxonomic decisions by Brochmann et al. (1997).

Two Cape Verde species, *L. purpureus* Webb and *L. brunneri* Webb, have small flowers, whereas three other species have large flowers (*L. jacobaeus* L., *L. arborescens* Lowe ex Cout., *L. latifolius* Brand). The calyx is 5–8(9) mm long in the small-flowered group and (5)8–11 mm in the large-flowered group. The ranges of variation overlap between the two groups, but the vast majority of the material can be easily assigned to the right group using calyx length.

Lotus purpureus is present in most islands of the archipelago and is probably the only species known to São Vicente. It is characterized by leaves with a well-developed rachis, which are usually longer than basal leaflets. Basal leaflets are ovate to elliptic, often with maximum width in their proximal part and thus differing in shape from three terminal leaflets of a leaf. The name *L.*

purpureus should not be understood as an indication that this species always has purple flowers. Instead, flowers are often yellow in this species.

Lotus brunneri is restricted to the islands Maio, Boa Vista, Sal and possibly São Vicente (Brochmann et al. 1997), but most common on Boa Vista. According to Brochmann et al. (1997), *L. brunneri* can be distinguished from *L. purpureus* by 3–5-flowered (not 1–3(4)-flowered) umbels and (distal) leaflets linear to oblanceolate rather than obovate to oblanceolate. These are tendencies only, however, because one-flowered peduncles and even obovate leaflets are sometimes present in *L. brunneri*. Additional features should be taken into consideration, such as morphology of basal leaflets of a leaf. One or both basal leaflets are sometimes absent or strongly reduced in *L. brunneri* (thus leaves may have four or three leaflets). Rachis is sometimes (not always) very short in *L. brunneri* and it is the only Cape Verde species always having yellow petals. *L. brunneri* and *L. purpureus* have the widest distribution within the archipelago, a phenomenon that probably correlates with their ability to grow at sea level (large-flowered Cape Verde species do not grow at altitudes below 200 m: Brochmann et al. 1997).

Among the large-flowered species, *L. latifolius* is morphologically more isolated than *L. jacobaeus* and *L. arborescens*. Brochmann et al. (1997) suggested that *L. latifolius* can be distinguished from the two other species by the peduncle being longer than the subtending leaf. This is an important character, although variation across a plant should be considered rather than an individual measurement of peduncle length. For example, in most studied plants of *L. arborescens* there are few peduncles 1–3 times longer than their subtending leaves. Another feature of *L. latifolius* which is not observed in *L. jacobaeus* and *L. arborescens*, is a tendency to produce basal leaflets with maximum width in their proximal part. At least some leaflets on a plant are usually of such a shape. Finally, the keel tip is straight in *L. latifolius* and usually incurved inwards in *L. jacobaeus* and *L. arborescens*. The name *L. latifolius* is slightly misleading because the species does not possess the widest leaflets among Cape Verde *Lotus* taxa. It has very narrowly elliptic or narrowly oblanceolate to elliptic or narrowly obovate distal leaflets of a leaf. *L. latifolius* is restricted to the island Santo Antão.

Lotus jacobaeus and *L. arborescens* differ from each other in leaf morphology. Leaf rachis is less than 0.5 the length of the basal leaflets in *L. jacobaeus* and more than 0.5 the length of the basal leaflets in *L. arborescens* (Brochmann et al. 1997). Our study of ample cultivated material confirmed this distinction to be useful and almost no overlap in variation ranges has been observed. This is surprising if we consider the close overall similarity between the two species and usual variation of all morphological characters in the genus *Lotus*. Apart from rachis length, leaflet shape is also important. But this is a tendency only. Upper leaflets are very narrowly lanceolate or linear to narrowly obovate or elliptic in *L. jacobaeus* and oblanceolate to obovate in *L. arborescens*. There are sometimes difficulties in distinguishing *L. jacobaeus* from *L. brunneri* and *L. arborescens* from *L. purpureus*, but there are only few problematic specimens, and they can be all identified using a combination of characters. *L. jacobaeus* is restricted to two close islands, Fogo and Santiago in the southern island group, whereas *L. arborescens* grows only in São Nicolau, an island that is geographically closer to Santo Antão.

Studies of many accessions of *L. arborescens* in the common garden at Perth revealed a specimen with an unusual keel tooth (Sandral & Sokoloff 2005). Furter studies should be undertaken to understand if this abnormality is heritable.

It is clear that all Cape Verde species form a natural group. It is not possible, however, to indicate any character or a clear combination of characters that distinguish this group from other members of the section. There is no problem with distinctions from geographically closest mainland species *L. jolyi* and *L. chazaliei*. Among other features, the first species has pubescent fruit valves and the second has hairs on the outer surface of the standard, character states not observed in Cape Verde material. Other mainland species can be distinguished from the Cape Verde group by means of leaf morphology. The real problem is how to distinguish the Cape Verde group from endemics of the Canaries, although they are clearly different. The following tendencies are characteristic for the Cape Verde group: (1) generally large leaves (except *L. purpureus*); (2) long sterile bract at the base of an umbel, which is often longer than the calyx (except *L. purpureus*); (3) presence of well-developed glandular flower-subtending bracts; (4) a tendency to have brownish-purple petals or their parts (except *L. brunneri*); (5) a tendency to have incurved keel tip (except *L. latifolius*); (6) a tendency to have longitudinally folded blade of the standard petal. None of these features work in isolation, and hence only their combination and certain experience allows identification of Cape Verde versus Canarian plants. There is probably closest resemblance between *L. purpureus* (Cape Verde) and *L. emeroides* (the Canaries). Kirkbride (1999) reported *L. bollei* Christ (a synonym of *L. purpureus*) from the Canaries and Cape Verde. We can confirm that *L. purpureus* is restricted to Cape Verde only. An additional criterion distinguishing this species from *L. emeroides* is calyx morphology. In *L. emeroides*, the calyx is usually longer than 7.5 mm and calyx teeth are as long as or longer than the tube. In *L. purpureus*, calyx is usually shorter than 7.5 mm and the teeth are as long as or shorter than the tube.

Almost every Cape Verde species has strong variation in stem and leaf indumentum type and corolla color is variable in four of five species. Early students of Cape Verde *Lotus* considered differences in these characters as *a priori* specific, probably because they are usually stable at the specific level in other parts of *Lotus* range. It is indeed interesting that the identification key by Mader & Podlech (1989) for *Pedrosia* in Morocco operates with an almost entirely different set of characters (including stem indumentum and petal color) than the Cape Verde key by Brochmann et al. (1997). We confirm that this is not due to different approaches of different authors but due to peculiar structure of the biodiversity.

Identification key for *Lotus* section *Pedrosia*

1 Standard at anthesis strongly reflexed backwards (to the pedicel), very long and narrow, folded throughout its length, and acute at the tip. Standard and wings with some hairs on outer side. Keel with a very long and narrow, distally incurved beak (fig. 1). Flowers very large, (2)2.5–3.5(4) cm long. Leaves with 5–7(8) leaflets. .... ***Lotus berthelotii*-group**
(not treated in the present paper)

— Standard not reflexed backwards, glabrous or pubescent. Wings glabrous. Flowers usually less than 2.5 cm long. Leaves with (3–)5(6) leaflets. **2**

2(1) All peduncles on a plant are shorter than their subtending leaves. Umbels 1(–2)-flowered. (Azores, Madeira, Salvage Islands) **3**

— All or nearly all peduncles on a plant are longer than their subtending leaves. If they are all shorter than subtending leaves, then at least some umbels are more than 2-flowered. **6**

3 Outer surface of standard with some hairs. Fruits densely covered by hairs, relatively short (usually as long as the calyx to 2.5 times longer than the calyx), usually with one or several very deep constrictions between seeds (fruit width is typically 0.6–1 mm in the constriction region and 1.5–3 mm in regions with developed seeds). Leaflets linear to (ob)lanceolate. Peduncles are less than 3 mm long (the flowers appear to be solitary in axils on foliage leaves, but in fact these are not just flowers but reduced one-flowered umbels). Flowers blackish-purple to pink. .... **(10) *Lotus loweanus***

— Standard completely glabrous. Fruit without deep constrictions. Mature fruits with sparse hairs or glabrous, often much longer than the above. **4**

4 Corolla yellow or orange, 10–15 mm long. Leaf rachis usually less than half as long as the basal leaflets. Basal leaflet length is three times or more, longer than their width. Plants without clear shoot differentiation: every shoot bears axillary umbels (along with lateral branches). .... **(14) *Lotus glaucus***

— Corolla typically violet, red, or purple to white, 13–25 mm long. Leaf rachis 2–15 mm long, more than half as long as the basal leaflets. Basal leaflet length is not more than two times longer than their width. Plants often with two shoot types: main shoots do not produce axillary umbels but only lateral shoots which may bear (in their proximal part) axillary umbels. **5**

5 Leaves with silvery indumentum of dense appressed or (rarely) patent hairs. Leaf rachis usually shorter (to slightly longer) than the basal leaflets. Axillary umbels arise on (second) third to fourth node of lateral shoots. .... **(12) *Lotus argyrodes***

— Indumentum less prominent, so that the foliage has no silvery appearance. Leaf rachis longer (often 2 times) than basal leaflets. Leaflets tend to be smaller than in the preceding species. Axillary umbels usually arise on the first (second) node of lateral shoots. .... **(11) *Lotus macranthus***

6(2) Ovaries and fruits are covered by hairs along the whole surface. (Mainland Africa[2]) .. **7**

— Ovaries and fruits are covered by hairs along the ventral suture only (i.e. along the line closest to the flower standard) or the fruits are completely glabrous. **8**

7 Stem with a dense indumentum of long spreading hairs (some hairs up to 1.5 mm long). Basal leaflets of a leaf with maximum width in the lower or middle part of a leaflet. .... **(3) *Lotus eriosolen***

— Stem with indumentum of short (up to 0.8 mm) appressed hairs. Basal leaflets of a leaf with maximum width in the upper or middle part of a leaflet. .... **(4) *Lotus jolyi***

8 Stylodium tooth is absent or very small, scarcely visible. Stems and leaves are densely covered by silvery appressed hairs. Leaf rachis considerably flattened, up to 3 mm wide, 1–5 mm long, much shorter than basal leaflets. Basal leaflets 3–15 mm long, with maximum width usually in the lower part of a leaflet, typically lanceolate or ovate (less often elliptic) and more or less unequally sided. Distal leaflets obovate to oblanceolate. Corolla yellow. Wings usually adhering together in their distal parts. Keel tip straight. .... **(8) *Lotus creticus***

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[2] We have observed, though very rarely, fruits with hairs along whole surface also in *L. glaucus* (Madeira) and *L. tenellus* (Canary Islands). For identification of these species go to 8. Morphologically, they differ from mainland African species with pubescent fruits by absence of well-detectable stipules. Leaves of *L. eriosolen* and *L. jolyi* have small (up to 0.3 mm long) but detectable dark glandular stipules.

— Stylodium tooth usually well developed. If the tooth is small (seldomly), some other characters are not as described above. **9**

9 Most leaves on a plant are trifoliate, i.e. with suppressed basal leaflets. Stipules and flower-subtending bracts are present as small dark glands. Keel tip usually incurved. (Cape Verde) **10**

— Leaves with five (rarely six) leaflets. **11**

10 Umbel peduncles are 1.5–3.5 times longer than their subtending leaves. Calyx 6–7 mm long. Anthetic petals entirely yellow. Stem and leaves with appressed hairs. .... **(26) *Lotus brunneri***

— Most umbel peduncles on a plant are either shorter than or as long as their subtending leaves. Calyx (6)8–11 mm long. Anthetic petals usually yellow with brownish-purple, rarely up to entirely yellow. Stem and leaves with appressed or patent hairs. .... **(29) *Lotus jacobaeus***

11(9) In all or many leaves of a plant basal leaflets more or less orbicular (length ≈ width). Rachis half as long as the basal leaflets or longer. **13**

— Basal leaflets longer (leaflet length > width) or/and rachis less than half as long as the basal leaflets. **12**

12 Basal leaflets (in pinnate leaves) or outer leaflets (in palmate leaves) with maximum width in their lower part, considerably different from the upper (middle) leaflets. **13**

— Leaflets of the basal pair with maximum width near their middle or in their upper part. Sometimes basal leaflets with parallel margins, which makes the exact position of maximum width unclear. **26**

13(11,12) Fruits strongly curved (typically to form semicircle). Ovary and fruit completely glabrous. Stems are covered by long (up to 1.5 mm) hairs, which are usually straight and patent. (Morocco) .... **(2) *Lotus maroccanus***[3]

— Fruits straight. Ovary and fruit glabrous or with some hairs along the ventral suture. Hairs straight or curved, patent or appressed. **14**

14 Plants usually annual. Stem indumentum of curved hairs, some of which are usually long and patent, whereas some others are short. Leaflets of the basal pair very prominently widened near their base, almost triangular in shape. Calyx teeth longer than the tube. Wing petals 5–7 mm wide, in side view of the flower they cover almost whole keel. Ovary and fruit always completely glabrous. (Mainland Europe and Morocco) .... **(1) *Lotus arenarius***

— Plants usually perennial. Leaflets of the basal pair less prominently widened near the base, usually not triangular (almost triangular only in *L. lancerottensis*: here stem hairs are all straight or, if curved, then short and appressed). Calyx teeth longer or shorter than the tube. Wing petals less than 5 mm wide. Ovary and fruit with some hairs along the ventral surface or glabrous. **15**

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3) When fruits are not available, *L. maroccanus* can be confused with *L. arenarius*. Additional characters of *L. maroccanus* are perennial life form and straight stem hairs (*L. arenarius* is an annual with curved hairs). However, it is often difficult to distinguish between annuals and perennials in herbarium material, and stem hairs can be sometimes curved in *L. maroccanus*.

15 Leaf rachis usually longer than leaflets of the basal pair. Basal leaflets usually ovate to elliptic. Flower subtending bracts are visible at the base of pedicels as very small scales with dark glandular tissue along the upper part of internal side. Umbels 1–2(4)-flowered. Calyx 5–8 mm long, teeth as long as or shorter than the tube. Corolla 10–15 mm long. (Cape Verde) .... **(25) *Lotus purpureus***

— At least one of the following character states is manifested: (1) glandular flower-subtending bracts are absent (only the large foliage leaf at the top of the peduncle is usually present); (2) calyx longer, up to 11 mm long; (3) calyx teeth considerably longer than the tube; (4) umbels with 4 and more flowers; (5) leaf rachis considerably shorter than leaflets of the basal pair. **16**

16 Most leaves on a plant with rachis less than half as long as the basal pair of leaflets or the rachis is absent (leaves palmate). **17**

— Most leaves on a plant with rachis more than half as long as the basal pair of leaflets. **22**

17 Standard with some hairs on the outer surface. Stem and leaves with dense white indumentum of straight appressed hairs. Leaf rachis up to 1 mm long. Distal leaflets 1–5.5 mm long. Umbels 1–3-flowered. Flowers small (wings 6–8 mm long). Stylodium 4.5–5.3 mm long. (Mainland Africa) .... **(9) *Lotus chazaliei***

— Standard glabrous[4]. **18**

18 Corolla (15–)16–18 mm long. Small glandular flower-subtending bracts usually present (along with a large foliage leaf at the base of the umbel). Calyx (8–)9–11 mm long, teeth as long as the tube or shorter than the tube. Anthetic petals yellow or yellow with brown areas at distal parts of wings. (Cape Verde) .... **(27) *Lotus latifolius***

— Corolla 10–15 mm long. Calyx 5–9 mm long. Small glandular flower-subtending bracts present or absent. Anthetic petals yellow or orange. **19**

19 Leaves with conspicuous dark glandular stipules up to 0.3 mm long. (Chad) .... **(5) *Lotus tibesticus***

— Leaves without conspicuous glandular stipules. **20**

20 Stems densely covered by straight patent hairs, so that stem surface is usually not visible between them. (Morocco) .... **(6) *Lotus assakensis***

— Stems with appressed hairs (dense or sparse) or the hairs are patent, but in the latter case they are more or less curved and not so dense. **21**

21 Distal parts of keel petals adhering together. Stems with dense sericeous indumentum of straight appressed hairs. Umbels 1–6-flowered. (Morocco) ..... **(7) *Lotus pseudocreticus***

— Distal parts of keel petals free. Stem indumentum as above or of sparse hairs, those are either straight or curved. Umbels 1–2(4)-flowered. (Macaronesian islands) **42**

22(16) Basal leaflets from narrowly lanceolate to narrowly ovate or elliptic, 3–19 mm long. Umbels (1–)3–6-flowered. Small glandular flower-subtending bracts usually present (along with a large foliage leaf at the base of the umbel). Calyx (8–)9–11 mm long, teeth as

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[4] Pubescent standard has been found also in one specimen of *L. assakensis*, but *L. assakensis* differs from *L. chazaliei* in patent stem hairs.

long as the tube or shorter than the tube. Corolla (14–)16–18 mm long. (Cape Verde) .... **(27)** ***Lotus latifolius***

— Small glandular flower-subtending bracts usually absent (but the foliage leaf at the base of umbel usually present). Calyx 6–9 mm long, teeth (at least lower ones) as long as to considerably longer than the tube. (Canary Islands) **23**

23 Calyx tube half as long as the teeth or shorter. Basal leaflets almost orbicular to elliptic, broadly ovate or broadly obovate. Leaves, pedicels, and calyx covered by long spreading and incurved hairs. Calyx with hairs only along the veins. .... **(24)** ***Lotus callis-viridis***

— Calyx tube usually more than half as long as the teeth. If calyx tube is as short as above, then indumentum is not as above. **24**

24 Distal leaflets triangular to orbicular, with width usually ≈ length (less often obovate). Basal leaflets typically equally sided, orbicular, elliptic, broadly ovate or broadly obovate, without distinct lateral veins. Calyx with hairs only along the veins or along the whole outer surface. Corolla yellow or yellow with red or reddish areas on some petals. .... **(23)** ***Lotus emeroides***

— Distal leaflets narrower, typically obovate, rarely oblanceolate. Basal leaflets equally or unequally sided. If basal leaflets all equally sided they are with distinct lateral veins (in herbarium). Petals yellow. **25**

25 Basal leaflets triangular to ovate or orbicular, typically pronouncedly unequally sided. Peduncles often not more than 2–3.5 times longer than subtending leaves. .... **(13)** ***Lotus lancerottensis***

— Basal leaflets ovate to elliptic, equally or slightly unequally sided. Peduncles often longer. .... **(22)** ***Lotus campylocladus***

26(12) All leaves of a plant are palmate and sessile (without a rachis or petiole, very rarely with a very short rachis up to 1 mm long, and in this case the leaflets are linear and at least some umbels with four or more flowers). **27**

— All leaves or part of leaves of a plant are distinctly pinnate with visible rachis, rarely leaves are petiolate and trifoliolate. If the rachis is very short, then the leaflets are not linear and the umbels are 1–3-flowered. **32**

27 Distal leaflets large, often some leaflets on a plant more than 20 mm (but few leaflets may be as short as 6 mm). Peduncles usually as long as or shorter than subtending leaves. Leaflets of the foliage leaf at the base of the umbel are as long as or longer than the calyx. Flowers usually purple-black, rarely with some (parts of) petals yellow, quite rarely all petals yellow. Keel tip usually slightly incurved inwards. (Cape Verde) .... **(29)** ***Lotus jacobaeus***

— Distal leaflets not more than 20 mm, often less than 10 mm. Peduncles longer than subtending leaves. Leaflets of the foliage leaf at the base of the umbel are shorter than the calyx, rarely as long as the calyx. Flowers yellow. Keel tip straight. (Canary Islands) **28**

28 Leaves and stems very densely covered by straight patent hairs. Leaflets obovate or orbicular, quite succulent. Stylodium tooth hairy (always?). .... **(18)** ***Lotus kunkelii***

— Leaves and stems with straight or patent but not so densely inserted hairs. Leaflets filiform to obovate or orbicular. Stylodium tooth glabrous. **29**

29 Calyx 9–10 mm long and more. Leaflets linear. .... **(20)** ***Lotus mascaënsis***

— Calyx 5–8(9) mm long. **30**

30 Stem hairs appressed. **31**

— Stem hairs patent (at least in the upper part of the stem). .... **(17)** ***Lotus sessilifolius***

31 Leaflets filiform, linear, lanceolate. Calyx 6.5–8(9) mm long. .... **(17)** ***Lotus sessilifolius***

— Lateral leaflets obovate or orbicular; central leaflets oblanceolate to obovate or (broadly) elliptic. Stem and leaf indumentum is dense, silvery. Calyx 5–6 mm long. .... **(19)** ***Lotus arinagensis***

32(26) Leaf rachis usually longer than leaflets of the basal pair, always more than 0.5 the length of the basal leaflets. Basal leaflets elliptic. Distal leaflets elliptic, orbicular or obovate. Umbels 1–2(3)-flowered. Calyx 5–7.5 mm long. Keel tip usually incurved inwards. (Cape Verde) .... **(25)** ***Lotus purpureus***

— Not as above: either the leaflets are narrow (linear or lanceolate) or the rachis is shorter or the calyx is longer. **33**

33 Calyx 6–7 mm long. Corolla 11–13 mm long, almost always yellow. Keel tip clearly incurved inwards. Leaflets linear to oblanceolate (rarely up to obovate). (Cape Verde) .... **(26)** ***Lotus brunneri***

— Calyx 8 mm long and more or/and keel tip straight. **34**

34 Leaflets tend to be large (larger leaflets on a plant typically more than 11 mm, often 13–40 mm long). Leaflets of the foliage leaf at the base of the umbel usually as long as the calyx or longer than the calyx. Flower-subtending bracts are visible at the base of pedicels as very small scales with dark glandular tissue along the upper part of internal side. Dark tissue is best visible when pedicel is detached from the peduncle. Flowers yellow to purple-black. Keel tip incurved inwards or straight. (Cape Verde) **35**

— Leaflets tend to be small (larger leaflets on a plant typically less than 11 mm, sometimes up to 15 mm, in this latter case they are narrowly oblanceolate or linear). Leaflets of the foliage leaf at the base of the umbel usually shorter than the calyx. Flower-subtending bracts are most often not detectable (only the large foliage leaf at the top of the peduncle is usually present). Anthetic flowers yellow or orange. Keel tip straight. (Canary Islands, Madeira, Chad) **37**

35 Most peduncles on a plant are longer than their subtending leaf. Keel tip straight. .... **(27)** ***Lotus latifolius***

— Most peduncles on a plant not longer than their subtending leaf. Keel tip usually incurved inwards. **36**

36 Leaf rachis is less than 0.5 the length of the basal leaflets. Upper leaflets very narrowly lanceolate or linear to narrowly obovate or elliptic. .... **(29)** ***Lotus jacobaeus***

— Leaf rachis is more than 0.5 the length of the basal leaflets. Upper leaflets oblanceolate to obovate. .... **(28)** ***Lotus arborescens***

37(34) Calyx 9.5 mm long, often longer; covered with patent hairs. Leaflets linear. (Tenerife) .... **(20)** ***Lotus mascaënsis***

— Calyx not exceeding 9 mm. **38**

38 Leaf rachis slightly shorter (never more than twice) to longer than basal leaflet pair. **39**

— Leaf rachis considerably shorter than basal leaflet pair (usually more than twice shorter). **40**

39 Basal leaflets of a leaf 2–10(11) mm long, lanceolate or oblanceolate to linear, equally sided. Distal leaflets of a leaf oblanceolate to linear. Leaf rachis slightly shorter or as long as basal leaflets. Stem and leaf indumentum of straight appressed or straight (rarely slightly curved) patent hairs. Calyx teeth shorter than the tube or upper teeth as long as the tube. Stylodium 5–6.5 mm long[5]. (Gran Canaria) .... **(21)** ***Lotus spartioides***

— Basal leaflets of a leaf lanceolate or oblanceolate to almost orbicular (i.e. in contrast to *L. spartioides*, they are never linear). Distal leaflets wider than linear. Leaf rachis slightly shorter to longer than basal leaflets (i.e. in contrast to *L. spartioides*, the rachis can be longer than basal leaflets). Stems and leaves often (not always) with curved hairs, which are either appressed or patent. Upper calyx teeth usually longer than the tube. Stylodium 6–7.5 mm long. .... **(22)** ***Lotus campylocladus***

40(38) Distal leaflets linear to linear-lanceolate (rarely up to obovate). A dwarf shrub typical for pine forest of upper elevations. Stems densely covered by straight appressed or patent hairs. Umbels (1)2–10-flowered. (Gran Canaria) .... **(21)** ***Lotus spartioides***

— Distal leaflets wider or if they are rarely narrow, then plant is not shrubby. Umbels 1–3(5)-flowered. **41**

41 Leaves with conspicous dark glandular stipules up to 0.3 mm long. Stem hairs either not straight or not appressed. (Chad) .... **(5)** ***Lotus tibesticus***

— Glandular stipules inconspicuous or if they are rarely visible, then stems with straight appressed hairs. (Canary Islands to Madeira) **42**

42(21,41) Stem hairs curved and/or patent. .... **(16)** ***Lotus tenellus***

— Stem hairs straight and appressed. **43**

43 Stem indumentum dense, sericeous, so that stem surface is not visible between hairs. **44**

— Stem indumentum not dense, so that stem surface is well visible between hairs. **45**

44 Anthetic petals orange, rarely yellow. Calyx teeth as long as or (less often) longer than the tube. Perennial herb of low elevations forming dense mats, sometimes suffrutescent. Two or several umbel peduncles often develop in axil of the same leaf due to activity of serial buds. .... **(14)** ***Lotus glaucus***

— Anthetic petals yellow. Calyx teeth usually longer than the tube. A dwarf shrub or semi-shrub of high elevations. Additional buds of serial axillary complexes give rise paracladia

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[5] Data on stylodium length in *L. campylocladus – L. spartioides* are preliminary as we did not have enough measurements. It seems to be unlikely that such problematic species so easily differ by this character, and with increased sampling we will likely find certain overlapping.

or innovation shoots, not umbel peduncles (i.e. only one umbel peduncle typically develop in a node). .... **(15)** ***Lotus dumetorum***

45(43) Anthetic petals yellow. Umbel peduncles 2–6 times longer than their subtending leaves. .... **(16)** ***Lotus tenellus***

— Anthetic petals usually orange. Umbel peduncles 1–3(4) times longer than their subtending leaves. .... **(14)** ***Lotus glaucus***

(1) ***Lotus arenarius*** Brot., Fl. Lusit. **2**: 120 (1804). ≡ *Pedrosia arenaria* (Brot.) R. Lowe, J. Linn. Soc., Bot. **5**: 38 (1861). – Protologue: [Portugal] "in arenosis maritimis Costa da Trafaria trans Tagum".

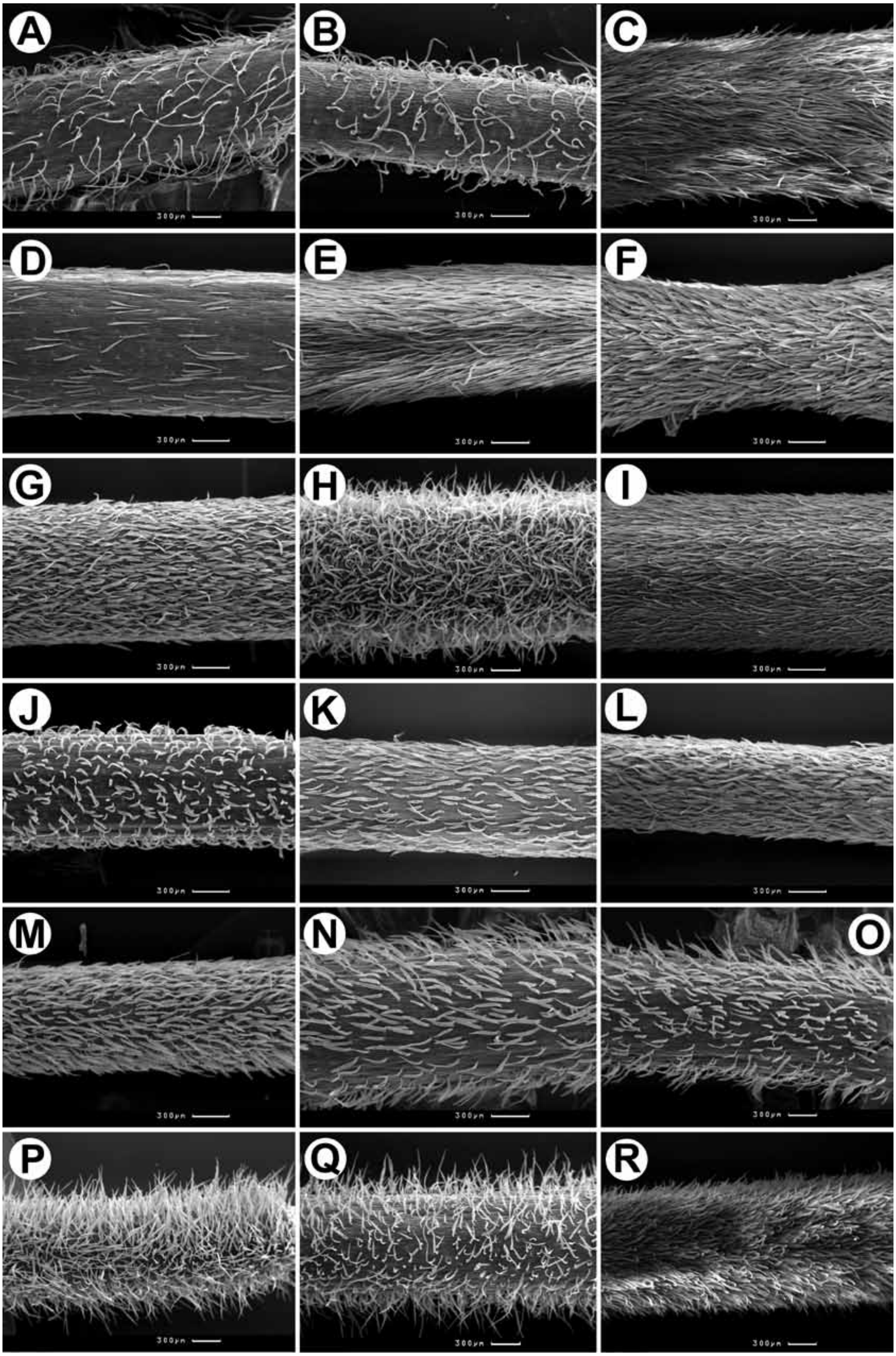
= *Lotus aurantiacus* Boiss., Elench. pl. nov.: 37 (1838). – Specimen from locus classicus: "885. *Lotus aurantiacus* Boiss. Malaca (Dehesilla)" [K!].

= *Lotus canescens* Kuntze, Flora **29**: 697 (1846). ≡ *Lotus arenarius* Brot. var. *canescens* (Kuntze) Brand, Bot. Jahrb. Syst. **25**: 199 (1898). – Original material: "534. *Lotus canescens* Kze. n.sp. Isthm. Gadit. ad eccles. Sti. Josephi." [K!].

= *Lotus arenarius* var. *webbii* Ball, J. Linn. Soc., Bot. **16**: 423 (1878), p.p., excl. lectotypo.

Illustrations: figures 7 A, 8 A, 9 A, 10 A, 11 (left).

Typically annual herb with long prostrate, extensively branching shoots. Adventitious roots on shoots absent. Leaves shorter than or longer than stem internodes, with a short petiole (0.5–0.9 mm), pinnate, with five (as an exception six) leaflets. Stipules up to 0.2 mm long, reddish-brown, glandular, sometimes not detectable. Leaflets on short petiolules 0.4–0.6 mm long. Leaf rachis flattened, up to 1.8 mm wide, (1.5)2–9(11) mm long, shorter than or rarely as long as basal leaflets. Basal leaflets (1.5)2–10(15) mm long, very prominently widened near their base, usually almost triangular in shape and pronouncedly unequally sided. All three distal leaflets attached to the top of the rachis or the rachis slightly prolonged after insertion of two paired leaflets. Distal leaflets usually longer than basal ones, (2)3–15(19) mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stem indumentum of curved hairs, some of which are long and patent, whereas some others are short, sometimes only short curved hairs are present. Leaflets with usually long curved hairs. Stem and leaf indumentum moderately dense, with stem and leaf surface well visible between hairs. Shoots with a basal zone bearing axillary paracladia and a distal zone (sometimes very long, up to 27 nodes) bearing axillary umbels. Umbel peduncles (1)2.5–5(6.5) times longer than their subtending leaves. Sterile bract shorter than or as long as the calyx, with 3–4 leaflets and shortened rachis. Umbels 1–6-flowered. Flower subtending bracts (plus stipules of the sterile bract) form a very tiny disrupted brownish-red glandular ring at the top of the peduncle, or flower-subtending bracts not detectable. Pedicels 1–2 mm long. Calyx 6–11 mm long, monosymmetric, and more or less pronouncedly two-lipped. Both calyx lips longer than the tube. Upper lip longer than the lower lip; the teeth of the upper lip wider than those of the lower lip. Calyx tube and teeth outside with curved hairs, which are either more or less appressed or patent; straight appressed hairs inside calyx teeth usually present in distal part of a tooth but absent from its proximal part. Preanthetic and anthetic petals yellow; standard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with red strips inside at the base of its blade (keel tip also sometimes reddish). Postanthetic petals yellow or orange. All petals glabrous. Standard almost as long as or longer than the keel. Wings 9–14 mm long, longer than or as long as the keel, (3.5)5–6(7) mm wide, not adhering together in their distal parts. Keel 9–13 mm long, tip straight. Stylodium (5.5)6–7 mm long, tooth always present, glabrous, 0.4–0.6 mm long. Ovary completely glabrous. Fruit straight, not or slightly constricted between seeds, (1.5)2–4(4.5) times longer than the calyx.

Selected examined specimens: **Portugal**: *Ogilvie 37,* Estoril district [K]; *Trevelyan* s.n., Setubal, 20 Mar. 1836 [K]. – **Spain**: *Anonymous SA-34064* (seeds), cultivated in Perth (plot 247) and pressed in 2005 and 2006 [K, MW]; *Anonymous SA-34061* (seeds), cultivated in Perth (plot 284) and pressed in 2005 and 2006 [K, MW]; *Cannon 3418*, Cádiz, 1.5 km NW of Rota, 1 Aug. 1968 [BM]; *Huter et al. 742*, Dehesilla pr. Malaga, 17 May 1879 [K]; *Luque & Valdés 10357*, Prov. Cádiz, inter Jerez de la Frontera et Puerto de Santa Maria, 13 Apr. 1978 [AD]; *Pignant s.n.*, Fort St. Sebastien pres Cadix, 1826 [K]. – **Gibraltar**: *Kellart s.n.* [K]. – **Morocco**: *Anonymous SA-19681* (seeds), cultivated in Perth (plot 287) and pressed in 2005 [MW]; *Anonymous SA-37658* (seeds), cultivated in Perth (plot 260) and pressed in 2005 [MW]; *Beuselinck et al. SA-37666*, 31 km N of Meknes, ruins of Volubilis, 470 m, 21 Jun. 1989 (seeds), cultivated in Perth (plot 200) and pressed in 2005 [MW]; *Davis 54168*, Cap Beddouza, N of Safi, 50–100 m, 7 Apr. 1972 [RNG]; *Fernandez Casas et al. 6744*, a 4 km de Boujad cerca de Kasba-Tadla, 710 m, 12 Jun. 1982 [MA]; *Font Quer 349,* Prov. Tétouan, El Araix (Laraix), 23 Mar. 1930 [MA]; *Jury et al. 14199*, High Atlas, S of Marrakech, on road to Tizi-n-Test, c. 12 km NNE of Ijoukak, 31°5'N, 8°8'W, 930 m, 16 Mar. 1992 [RNG]; *Kirkbride et al. 5660*, highway from Tiznit to Tafraout, 33 km from Tiznit, 320 m, 4 Jun. 1989 [K]; *Kirkbride et al. 5688*, highway from Tiznit to Tafraout, 96 km from Tiznit, 1020 m, 4 Jun. 1989 [K]; *Kirkbride et al. 5721*, Prov. Safi, 27 km N of Chichaoua on highway S511, 250 m, 6 Jun. 1989 [K]; *Kirkbride et al. 5735*, 3 km E of Oued-Zem on highway P 13, 790 m, 9 Jun. 1989 [K]; *Kirkbride et al. 5839,* 19 km W of Meknes, 560 m, 14 Jun. 1989 [K]; *Kirkbride et al. 5843*, new Rabat-Sale highway at Rabat, 70 m, 14 Jun. 1989 [K]; *Kirkbride et al. 5849,* Prov. Khemisset, 17 km W of Rommani on highway S106, 410 m, 16 Jun. 1989 [K]; *Kirkbride et al. 5853*, northeastern edge of Kenitra on highway P2, 35 m, 17 Jun. 1989 [K]; *Kirkbride et al. 5909*, 31 km N of Meknes, Volubilis, the old Roman city, 410 m, 21 Jun. 1989 [K]; *Kirkbride et al. 5991*, Prov. Tétuoan, beach 2 km N of Martil, 5 m, 30 Jun. 1989 [K]; *Lippert 22590*, Prov. Marrakech, 4 km SE der Staumauer bei Lalla-Takerkous, 750 m, 23 Apr. 1987 [M]; *Lippert 24306*, Prov. Tétouan, N-Ufer des Lokkhos (N Larache), ca. 10 m, 23 Jun. 1989 [M]; *Lowe s.n.*, Mogadore, 4 May 1861 [K]; *Miller et al. 290*, 18 km N of Essaouira, Gorge du Chicht, 31°8'N, 9°6'W, 100 m, 30 Mar. 1974 [RNG]; *Podlech 43467*, Küste zwischen Rabat und Haoura, 5–10 km SW Rabat, 5–10 m, 1 May 1987 [M]; *Podlech 52555*, Antiatlas, Tizi-n-Mlil, 1650 m, 4 Apr. 1995 [M]. – Material of unknown origin: *Donald & Miles SA-729* (seeds), cultivated in Perth (plot 205) and pressed in 2006 [K, MW]. – There are also records from Egypt and Senegal, where the plant may not be native.

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Figure 7: Details of stem indumentum (SEM). All scale bars = 300 µm. A, *Lotus arenarius* (*Anonymous SA-34064*); B, *Lotus eriosolen* (*Beuselinck et al. SA-37667*); C, *Lotus creticus* (*Prendergast SA-34273*); D, *Lotus macranthus* (*Sandral et al. SA-39119*); E, *Lotus argyrodes* (*Sandral et al. SA-39282*); F, *Lotus glaucus* (*Sandral et al. SA-39117*); G–H, *Lotus lancerottensis* (G, *Sandral et al. SA-40320*; H, *Sandral et al. 04-S15-15-SS*); I, *Lotus dumetorum* (*Sandral et al. SA-40250*); J–K, *Lotus tenellus* (J, *Sandral et al. 04-S6-06-SS*; K, *Sandral et al. SA-39105*); L–O, *Lotus sessilifolius* subsp. *sessilifolius* (all images taken from *Sandral et al. SA-39064*); P–Q, *Lotus sessilifolius* subsp. *villosissimus* (both images taken from *Sandral et al. SA-40270*); R, *Lotus arinagensis* (*Sandral et al. SA-40278*). – All images and drawings of *Lotus* sect. *Pedrosia* have been made using living collections at Perth. Herbarium specimens have been collected from the same accessions.

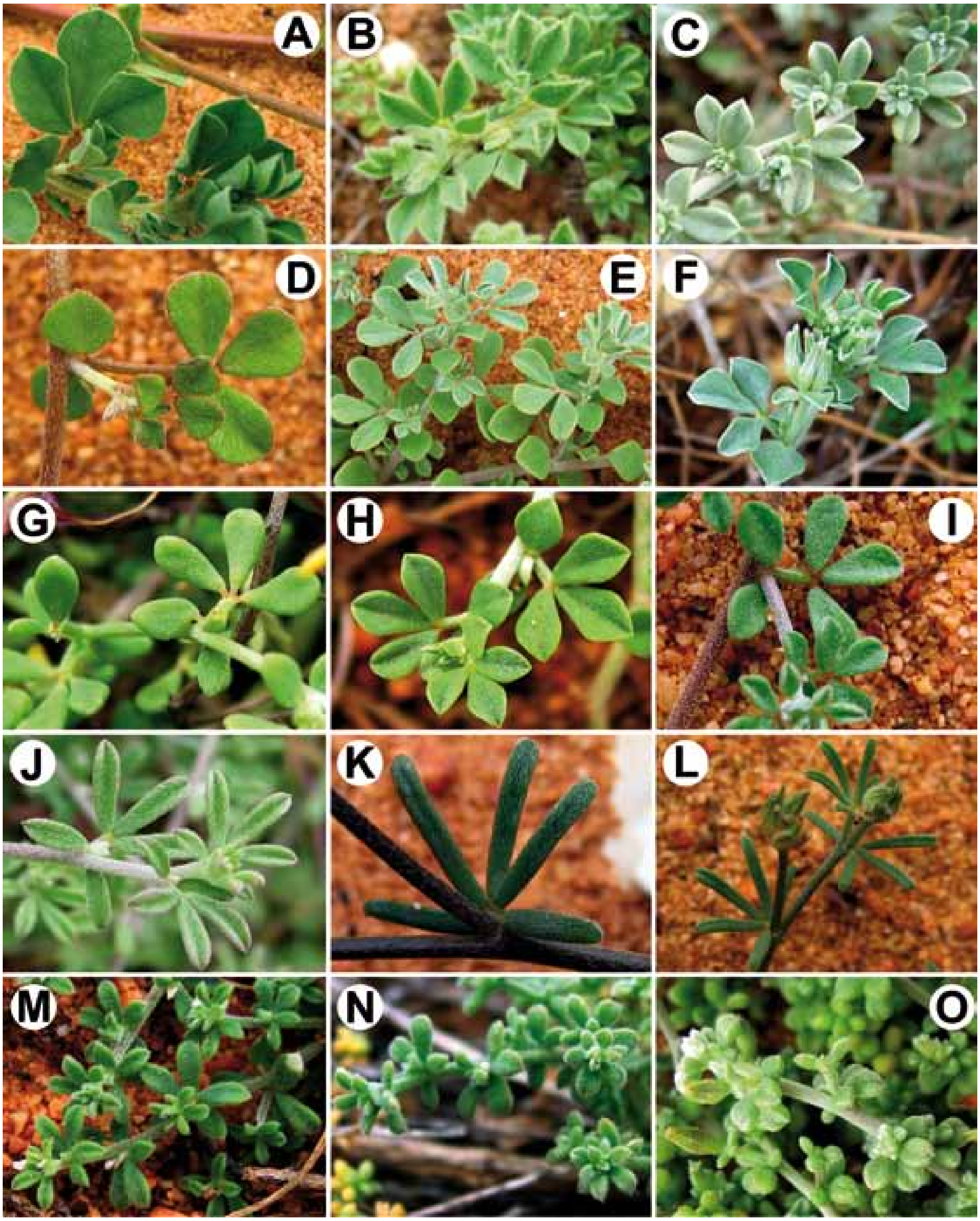

Figure 8: Photos showing leaf morphology. A, *Lotus arenarius* (*Anonymous SA-34064*); B, *Lotus eriosolen* (*Beuselinck et al. SA-37667*); C, *Lotus creticus* (*Sandral et al. SA-39213*); D, *Lotus macranthus* (*Sandral et al. SA-39119*); E, *Lotus argyrodes* (*Sandral et al. SA-39282*); F, *Lotus lancerottensis* (*Sandral et al. SA-40322*); G, *Lotus glaucus* (*Sandral et al. SA-39142*); H, *Lotus dumetorum* (*Sandral et al. SA-40248*); I–J, *Lotus tenellus* (I, *Sandral et al. SA-40281*; J, *Sandral et al. SA-39105*); K–L, *Lotus sessilifolius* subsp. *sessilifolius* (both images taken from *Sandral et al. SA-39087*); M–N, *Lotus sessilifolius* subsp. *villosissimus* (M, *Sandral et al. SA-40266*; N, *Sandral et al. SA-40264*); O, *Lotus arinagensis* (*Sandral et al. SA-40278*).

(2) *Lotus maroccanus* Ball, J. Bot., N.S. **2**: 306 (1873). – Lectotype (designated by Mader & Podlech 1989, Mitt. Bot. Staatssaml. München **28**: 556): *Hooker s.n.*, Morocco, Agadir, Apr.–May 1871 [K-000262765!, isolectotype P!].

Perennial herb or (according to Mader & Podlech 1989) rarely a half-shrub; rootstock up to 1cm thick. Adventitious roots have been found in one herbarium specimen but real frequency of their occurrence can be discovered only by study of living plants. Leaves shorter than or longer than stem internodes, almost sessile or with a petiole up to 1 mm long, pinnate, with five leaflets. Stipules up to 0.2 mm long, reddish-brown, glandular. Leaflets on short petiolules up to 0.5 (1.0) mm long. Leaf rachis flattened, up to 3 mm wide, 2–7(9) mm long, shorter than (often two times shorter than) basal leaflets. Basal leaflets (2)3–11(14) mm long, prominently widened near their base and prominently unequally sided, usually triangular-ovate or triangular-lanceolate, rarely almost orbicular. All three distal leaflets attached to the top of the rachis. Distal leaflets as long as or longer than basal ones, (2)4–12(16) mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stem indumentum of long straight or slightly curved hairs, sometimes also with short curved hairs. Leaves with usually long straight hairs. The indumentum relatively dense, but stem and leaf surface well visible between hairs. Shoots with a basal zone bearing axillary paracladia or innovation shoots, and a distal zone bearing axillary umbels. Umbel peduncles (1)2–5(6) times longer than their subtending leaves. Sterile bract shorter than or longer than the calyx, with 3–4 leaflets and shortened rachis. Umbels 1–6-flowered. Flower subtending bracts (plus stipules of the sterile bract) form a more or less disrupted brownish-red glandular ring at the top of the peduncle. Pedicels 1–2 mm long. Calyx (7.5)9–11 mm long, monosymmetric and more or less pronouncedly two-lipped. Both calyx lips longer than or as long as the tube. Upper lip longer than or as long as the lower lip; its teeth are wider than those of the lower lip. Calyx tube and teeth outside with long straight patent hairs; teeth also with straight appressed hairs inside. Petals yellow, keel often with red strips inside at the base of the blade, keel tip often reddish. All petals glabrous. Standard usually longer than the keel. Wings 11–16 mm long, shorter than to longer than the keel, (3.5)4–6(7.5) mm wide, not adhering together in their distal parts. Keel 12–15 mm long, tip straight. Stylodium 6.5–9.5 mm long, tooth always present, glabrous, 0.4–0.8 mm long. Ovary completely glabrous. Fruit curved, not or slightly constricted between seeds, 3–4 times longer than the calyx.

Examined specimens: **Morocco**: *Anonymous (Reading Univ./ B.M. Exped.) 652*, High Atlas, Asni, 1068 m, 13 Jun. 1974 [RNG]; *Anonymous 20*, Middle Atlas, 2 Jun. 1982 [BM]; *Bramwell et al. 505*, High Atlas, N side of Tizi-n-Test pass, on road to Marrakech, 31 Mar. 1972 [K, RNG]; *Bramwell et al. 531*, High Atlas, river gorge of Oued Moulay Brahim, 31 Mar. 1972 [RNG]; *Davis 54082*, 13 km E of Ait Ourir, 900 m, 6 Apr. 1972 [RNG]; *Fernandez Casas & Molero 13737*, Marrakech, prope Oumnas, 4 May 1992 [RNG]; *Hooker s.n.*, Agadir, Apr.–May 1871 [K]; *Hooker s.n.*, South Marocco, Greater Atlas, May 1871 [K]; *Jury 19572*, 72 km from Marrakech on road to Ouarzazate, near Toufliat, 1450 m, 3 Jun. 2002 [BM]; *Jury et al 14471*, 9 km NW of Talouine, 22 km SE of Aoulouz, main road to Tazenakht, 1080 m, 23 Mar. 1994 [RNG]; *Jury et al SL 19572*, c. 72 km from Marrakech on road to Ouarzazate, near Toufliat, 1450 m, 3 Jun. 2002 [RNG]; *Kirkbride et al. 5706,* Prov. Marrakech, 21 km from the junction of highways P32 and S501 going to Marrakech on highway S501, 1400 m, 5 Jun. 1989 [K]; *Kotali et al. 164*, 18 km from Azilal coming from Beni Mellal,1445 m, 14 May 2003 [K]; *Lid s.n.*, Haut Atlas, 1250 m, 11 Apr. 1926 [K]; *Lippert 22343*, Prov. Agadir, Hoher Atlas, 14 km NE der Hauptstrasse P 32 gegen den Tizi-n-Test, 1000–1100 m, 19 Apr. 1987 [M]; *Podlech 41522*, Prov. Beni-Mellal, Mittlerer Atlas, 3 km SW Cascades d'Ouzoud, ca. 1150 m, 23 Apr. 1986 [G]; *Podlech 42806*, Prov. Agadir, Hoher Atlas, 28 km NE der Hauptstrasse P 32 gegen den Tizi-n-Test,

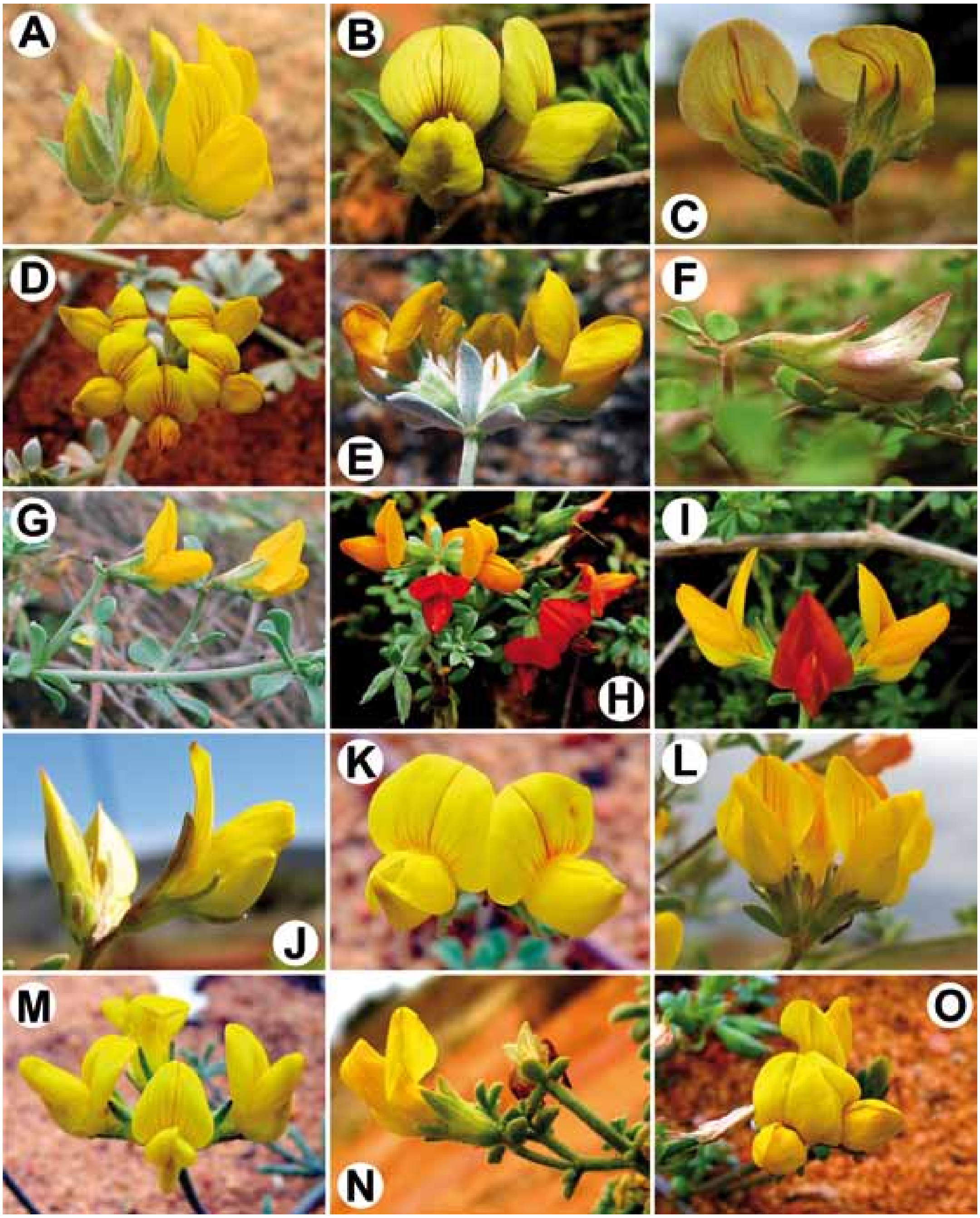

Figure 9: Photos showing flower morphology. A, *Lotus arenarius* (*Anonymous SA-34064*); B–C, *Lotus eriosolen* (B, *Beuselinck et al. SA-36497*; C, *Beuselinck et al. SA-37667*); D–E, *Lotus creticus* (both images taken from *Prendergast SA-34273*); F, *Lotus macranthus* (*Sandral et al. SA-39119*); G, *Lotus lancerottensis* (*Sandral et al. SA-40322*); H–I, *Lotus glaucus* (H, *Sandral et al. SA-39126*; I, *Sandral et al. SA-39133*); J, *Lotus dumetorum* (*Sandral et al. SA-39093*); K–L, *Lotus tenellus* (K, *Sandral et al. SA-40281*; L, *Sandral et al. SA-39105*); M, *Lotus sessilifolius* subsp. *sessilifolius* (*Sandral et al. SA-39087*); N, *Lotus sessilifolius* subsp. *villosissimus* (*Sandral et al. SA-40264*); O, *Lotus arinagensis* (*Sandral et al. SA-40278*).

1700–1850 m, 19 Apr. 1987 [M]; *Podlech 45775*, ibid., 1600–1700 m, 3 May 1989 [M, MA]; *Podlech 45935*, 4 km NW Tnine-Ourika an der Strasse nach Marrakech, 900 m, 4 May 1989 [MA]; *Whiting & Richmond 236*, High Atlas, Ioundra near Demnate, 3000 ft, 3 Apr. 1958 [K].

(3) *Lotus eriosolen* (Maire) Mader & Podlech, Mitt. Bot. Staatssamml. München, **28**: 544 (1989). ≡ *Lotus maroccanus* Ball var. *eriosolen* Maire, 1926, Mém. Soc. Sci. Nat. Maroc. **15**: 25. Lectotype (designated by Mader & Podlech, l.c.): *Nain 253,* Marokko, Prov. d'Er-Rachidia, Midelt, 14 Apr. 1920 [MPU, image seen].

Illustrations: figures 7 B, 8 B, 9 B–C, 10 B, 11 (right).

Perennial herb typically with numerous, long prostrate, extensively branching shoots; perennial stems often submerging into the soil and sometimes produce adventitious roots. Leaves shorter than or longer than stem internodes, with a short petiole (0.6–1 mm), pinnate, with five (as an exception six) leaflets. Stipules 0.1–0.2 mm long, reddish-brown, glandular. Leaflets on short petiolules 0.3–0.5 mm long. Leaf rachis flattened, 0.7–0.9 mm wide, (0.5)1–4(5) mm long, usually about half as long as basal leaflets or shorter. Basal leaflets (0.7–)1–10(14) mm long, with maximum width in the lower or middle part of a leaflet, ovate, elliptic, or lanceolate, equally or slightly unequally sided. All three distal leaflets attached to the top of the rachis. They are usually longer than basal leaflets (sometimes one of basal leaflets as long as or longer than distal leaflets), 1.5–10(12) mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stem and leaf indumentum of long (up to 1.5 mm long) straight patent and/or variously curved hairs. Stem and leaf indumentum moderately dense, with stem and leaf surface well visible between hairs. Leaflet surface was glaucous in our living plants. Shoot system and umbel arrangement may show several patterns. Proximal portion of a shoot (that is not always present) bear no lateral shoots, or these may be delayed in development. Sometimes this basal portion (if it develops in the soil) may bear reduced, scale-like leaves. Next portion of the shoot bears lateral shoots that repeat structure of main shoot. Then the shoot proceeds to initiation of lateral umbels, and their number is quite variable (from two to twenty), after which main axis may give rise to next portion of lateral repeating shoots. Sometimes nodes with lateral umbels and with repeating shoots do not form clear zones. In total, a shoot may include up to 62 nodes in our material. Shoot apical meristem may continue its activity during the next vegetation season. However, its second year activity is poor, and it seems that it will not be active anymore during the third season (although we examined two-years-old plants only). Umbel peduncles (0.5)1.5–5(7) times longer than their subtending leaves. Sterile bract shorter than or as long as the calyx, with (2)3(4) leaflets and shortened rachis. Umbels 1–2-flowered, less often 3-flowered. Flower subtending bracts (plus stipules of the sterile bract) form a disrupted brownish-red glandular ring about 0.07–0.1 mm in height at the top of the peduncle. Pedicels 1–3 mm long. Calyx 6–11 mm long, monosymmetric, and more or less pronouncedly two-lipped. Both calyx lips slightly shorter to slightly longer than the tube. Upper lip as long as or slightly longer than the lower lip. Calyx tube and teeth outside with spreading hairs similar to those on stem and leaves, teeth also with few appressed hairs inside (lower teeth may be glabrous inside). Preanthetic and anthetic petals yellow with brownish red areas: usually keel yellow with brownish-red tip, wings yellow with brownish-red area near the base of the blade, standard blade yellow with red strips at the base inside and more or less brownish-red outside. Postanthetic petals often entirely brownish. All

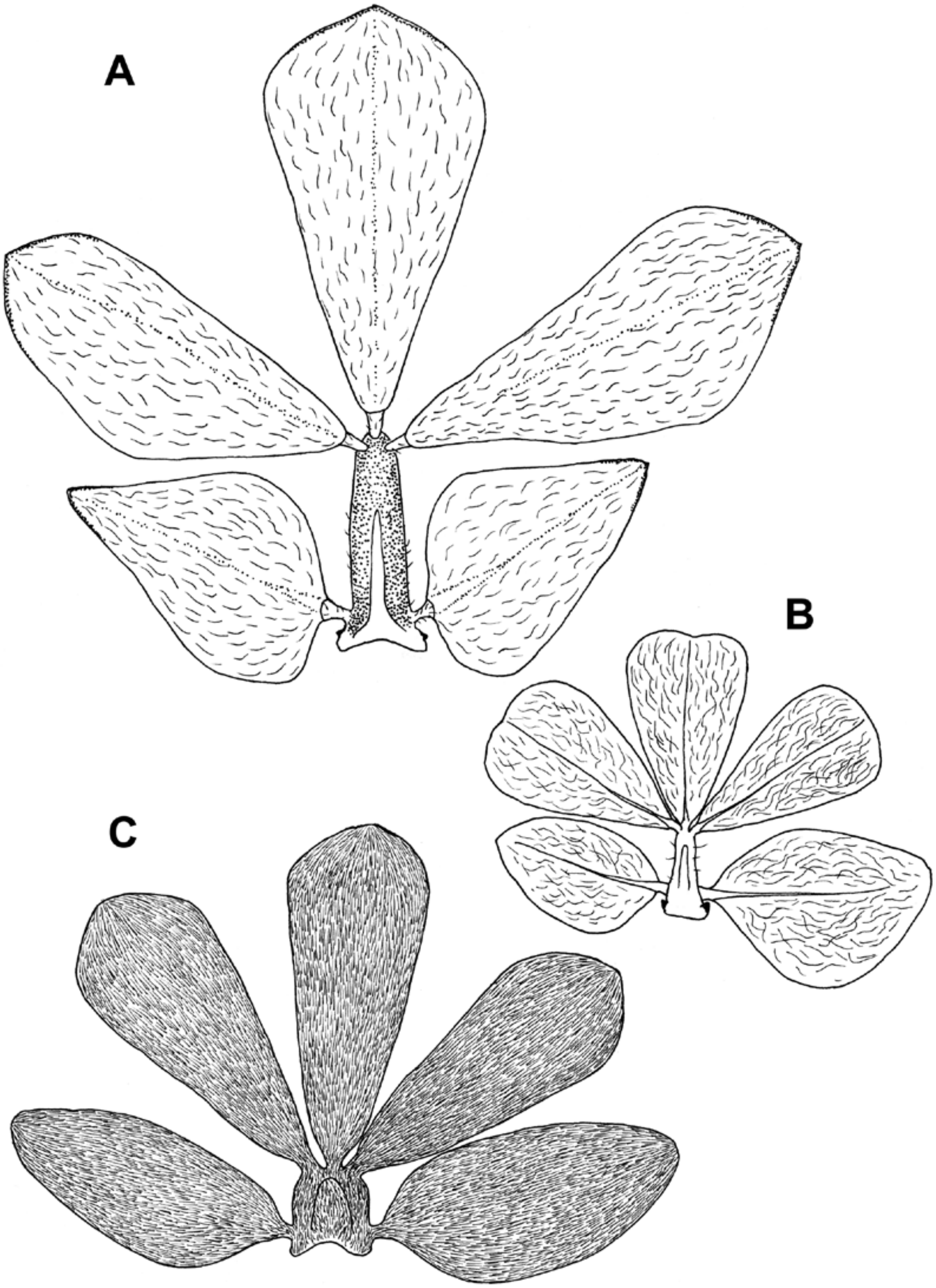

Figure 10: Leaf morphology (magnification 5:1). A, *Lotus arenarius* (*Anonymous SA-34064*); B, *Lotus eriosolen* (*Beuselinck et al. SA-37667*); C, *Lotus creticus* (*Sandral et al. 03-S71-213-SR*).

petals glabrous. Standard almost as long as the keel. Wings 9–13 mm long, shorter than or as long as the keel, 3.5–5 mm wide, not adhering together in their distal parts. Keel 10–13 mm long, tip straight or slightly curved. Stylodium 6–7.5 mm long, tooth always present, glabrous, 0.4–0.8 mm long. Ovary and fruit with hairs throughout the surface; they are longer along the ventral suture. Fruit straight, not or slightly constricted between seeds, 2–5 times longer than the calyx.

Selected examined specimens: **Morocco**: *Anonymous (OPTIMA Iter V) 281*, Outskirts of Midelt, on track to Cirque du Jaffar, Jbel Ayachi, 32°08'N, 4°46'W, 1500 m, 10 Jun. 1992 [RNG]; *Beuselinck et al. SA-36497*, Prov. Khenifra, Tizi-n-Talrhemt, 29 km S of Midelt on P21, 1900 m, 6 Dec. 1989 (seeds), cultivated in Perth (plot 299) and pressed in 2006 [K, MW]; *Beuselinck et al. SA-37667*, Prov. Ouarzazate, 55 km N of Boumalne-du-Dades on 6901 towards Msemrir, 1860 m, 26 Jun. 1989 (seeds), cultivated in Perth (plot 345) and pressed in 2005 and 2006 [K, MW]; *Bramwell et al. 565*, NW Sahara, Gorges du Dades, 2 Apr. 1972 [RNG]; *Brooks et al. E.5298*, Anti-Atlas, prov. Ouarzazate, mountain S of Ambed, 19 km E of Bou Azzer, 1400 m, 15 Apr. 1993 [RNG]; *Jury et al. 14504*, 16 km N of Tazenakht, 69 km SW of Ouarzazate, near Tizi-n-Bachkoum, 1650 m, 23 Mar. 1994 [RNG]; *Jury et al. 14550*, 11 km N of Tinerhir (Tingher), along road to Gorges du Todra, 1410 m, 25 Mar. 1994 [RNG]; *Jury et al. 14556* and *14557*, 15 km N of Tinerhir (Tingher), Gorges du Todra, 1405 m, 25 Mar. 1994 [RNG]; *Jury et al. 14624*, 71 km N from Er Rachidia, on Midelt road, 8 km NW Rich, 1140 m, 8 Jul. 1997 [RNG]; *Jury et al. 17674*, road from Imilchil to Tinghir, just S and E of Imilchil, 2300 m, 8 Jul. 1997 [BM, RNG]; *Kirkbride et al. 5810*, Prov. Khenifra, Tizi-n-Talrhemt, 29 km S of Midelt on highway P21, 1900 m, 12 Jun. 1989 [K]; *Kirkbride et al. 5922*, Prov. Ouarzazate, 55 km N of Boumalne-du-Dades on highway 6901, next to Oued Dades, 1860 m, 26 Jun. 1989 [K]; *Lewalle 13206*, Tazenakht (Ouarzazate), 800 m, 17 Oct. 1990 [RNG]; *Lippert 21922*, Prov. Taza, 18 km NE Missour, 850 m, 14 Apr. 1987 [M]; *Lippert 21944*, Prov. Fez, 15 km WSW Missour an der Strasse nach Ksabi, 1000 m, 14 Apr. 1987 [M]; *Lippert 22280*, Prov. Ouarzazate, Anti-Atlas, N'Hang des Tizi-n-Bachkoun, 16 km N Tazenakht an der Strasse nach Ouarzazate, 1650 m, 18 Apr. 1987 [M]; *Lippert 25235*, Prov. Ouarzazate, Hoher Atlas, 11 km oberhalb Agouim bei Igherm-n'Ougdal, ca. 2030 m, 8 Jul. 1989 [M]; *Maire & Wilczek 571*, ad radices montis Atlantis Magni orientalis, 20 Apr. 1933 [MA]; *Maire & Wilczek s.n.*, Ziz, 1100–1200 m, 8 Apr. 1933 [MA]; *Podlech 42726*, Prov. Ouarzazate, Antiatlas, N' Hang des Tizi-n-Bachkoun, 16 km N Tazenakht an der Strasse nach Ouarzazate, 1650 m, 18 Apr. 1987 [G, MA]; *Podlech 47837*, Prov. Ouarzazate, Hoher Atlas, 11 km oberhalb Agouim bei Igherm-n'Ougdal, ca. 2030 m, 8 Jul. 1989 [M]; *Podlech 52619*, Antiatlas, N' Hang des Tizi-n-Bachkoun, 16 km N Tazenakht an der Strasse nach Ouarzazate, 1650 m, 6 Apr. 1995 [M]; *Valachovič 1341-42*, High Atlas Mts., Gorges du Dades, 1450 m, 31 Mar. 1993 [RNG].

(4) ***Lotus jolyi*** Battand., Bull. Soc. Bot. France **47**: 251 (1900). – Lectotype (designated in P, as holotype): *Joly s.n.*, [Algeria] Sahara central, Tadmayt, Oued Inçokki, 14 Dec. 1899 [P-00084415!].

= *Lotus capillipes* Battand. & Trabut, Bull. Soc. Bot. France **58**: 670 (1911). – Holotype: *Laperrine s.n.* [Algeria] Sahara Central, Ahaggar [P-00084420!, isotype MPU].

= *Lotus arguinensis* Maire, Bull. Soc. Hist. Nat. Afr. N. **30**: 340 (1939). – Original material (holotype?): *Murat 2410*, Ile d'Arguin, 13 May 1938 [P, image seen].

Perennial herb with a thick rootstock. Leaves shorter than stem internodes, almost sessile or with a petiole up to 1 mm long, pinnate or subpalmate, with five leaflets and black triangular well visible stipules up to 0.3 mm long. Leaflets on short petiolules up to 0.6 mm long. Leaf rachis up to 2(3) mm long, much shorter than basal leaflets. Basal leaflets 1–11 mm long, with maximum width in the middle or upper part of a leaflet, (narrowly) elliptic or obovate to narrowly oblanceolate, equally sided. All three distal leaflets attached to the top of the rachis. They are longer than or as long as the basal leaflets, 1–12 mm long, with maximum width in the upper part of a leaflet,

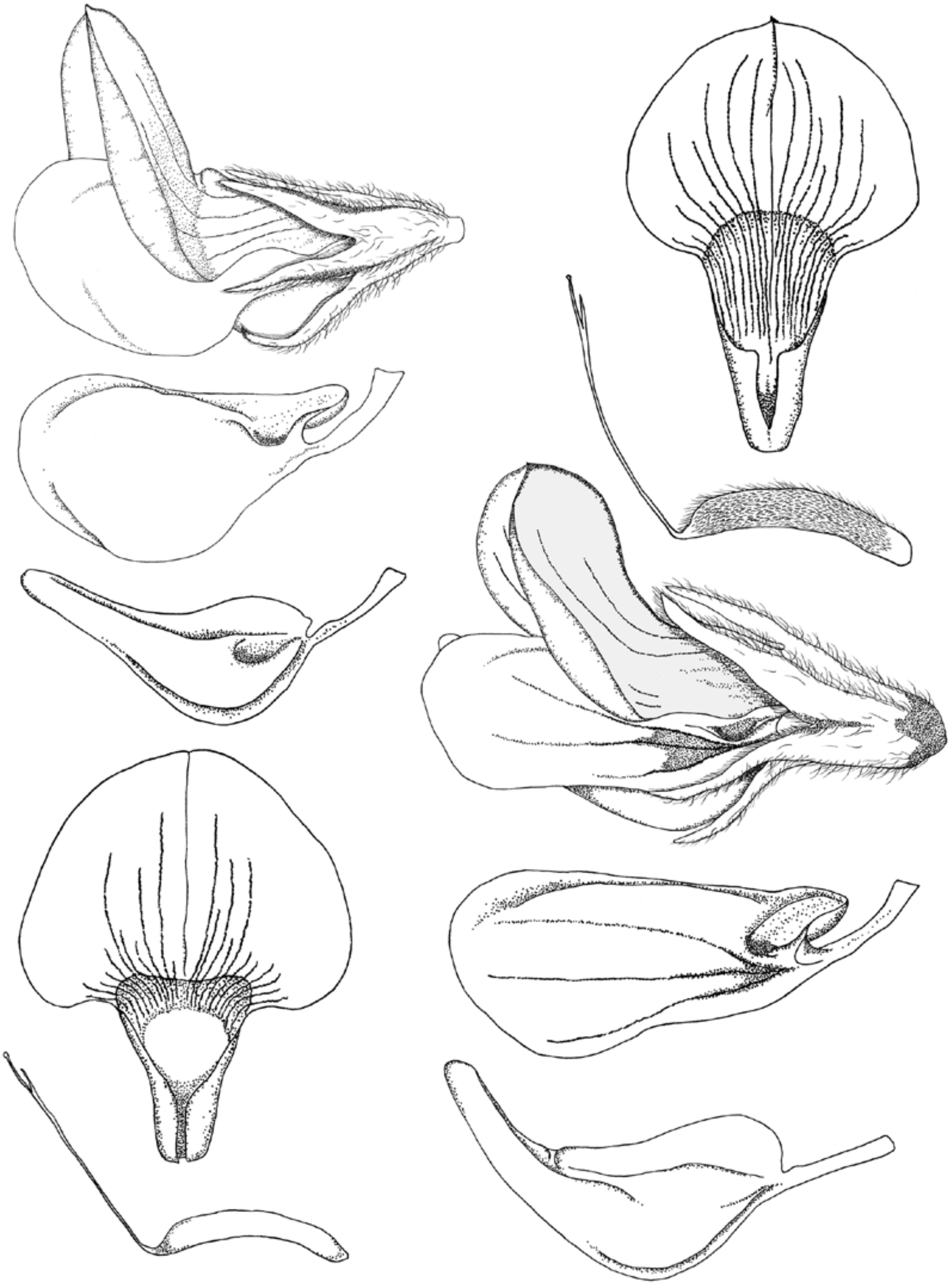

Figure 11: Flower morphology (magnification 5:1). Left: *Lotus arenarius* (*Anonymous SA-34061*); right: *Lotus eriosolen* (*Beuselinck et al. SA-36497*).

(narrowly) elliptic, obovate, or (narrowly) oblanceolate. Stem and leaf indumentum of (almost) straight and appressed hairs. Stem indumentum moderately dense, with stem surface visible between hairs. Shoots with a proximal innovation zone, then with a zone bearing paracladia or no axillary shoots (in the latter case this is the inhibition zone) and finally with a zone bearing axillary umbels. Additional buds in serial complexes typically do not develop shoots. Umbel peduncles (1)2–9 times longer than their subtending leaves. Sterile bract shorter than the calyx, usually with 3 leaflets and shortened rachis. Umbels 1–5-flowered. Flower-subtending bracts as well visible dark glands similar to stipules of foliage leaves. Pedicels 0.5–2 mm long. Calyx 7–10 mm long, slightly monosymmetric and two-lipped. Lower teeth almost as long as the tube; upper teeth usually longer than the tube. Calyx tube and teeth outside and the teeth inside with appressed hairs. Corolla glabrous, yellow, or, more frequently, bicolor with red and yellow colors. All petals of almost the same length, 8.5–12 mm long. Wings not adhering together in their distal parts. Keel tip straight. Stylodium 5–6.5 mm long, tooth always present, glabrous, 0.4–0.6 mm long. Ovary with hairs covering whole surface; these hairs are appressed and often not conspicuous in fruits. They are still always present in all examined specimens, although Mader & Podlech (1989), who studied more material, reported that the ovary is rarely glabrous. Fruit straight, not or slightly constricted between seeds, (2)3–4 times longer than the calyx.

Selected examined specimens: **Morocco**: *Areual s.n.*, entre Ksur es Souk y Zenerhiz(?), 10 May 1974 [MA]; *Maire & Wilczek 130*, regio desertica orientalis, Taomart, 9 Apr. 1933 [MA]; *Podlech 48951,* 11 km NW Tilemsen an der Piste nach Tan-Tan, 170 m, 2 Apr. 1990 [M]; *Schuhwerk 90/263*, 8 km NW Tan-Tan, wenig N der Strasse P 41 nach Tan-Tan Plage, 27 Mar. 1990 [M]; *Schuhwerk 90/338*, ca. 7 km N Tan an der Strasse P 41 von Tarfaya nach Layoune, 28 Mar. 1990 [M]; *Smith 153*, N of Erfoud, Mar. 1982 [RNG]. – **W. Sahara**: *Moralès-Agacino & Rungs 202*, basin de la Seguiet el Hamra, 35 km au S de Semara, 3 May 1942 [MA]. – **Mauritania**: *Popov 24*, near Nouakchott, 30 m, 10 Apr. 1959 [BM]. – **Algeria**: *Chevalier 572*, "Oued Arreyed, oued Tebalboulet, oued Saret, etc., in glareosis fluv., usque ad Sahab es Ser, inter Inifel et El-Goléa" Mar. 1904 [K, MA]; *Joly s.n.*, Tadmayt, Oued Inçokki, 14 Dec. 1899 [P]; *Laperrine s.n.* Ahaggar [P]; *Meinertzhagen 42*, 24°N, 6°E, 5900 ft, 10 Mar. 1931 [K]; *Podlech 34918*, Wilaya Tamanrasset, Hoggar-Massif, Guelta Afilale, nahe der Strasse von Tamanrasset zum Assekrem, 2000–2050 m, 20 Mar. 1981 [M]. – **Chad** (Identification of these specimens as *L. jolyi* and their relation to *L. tibesticus* need future investigations): *Grove & Johnson 52*, Tibesti, Tarso Toussidé, Rhyolite, 5–6000 ft, 25 Aug. 1957 [K]; *Monod 8289*, Tibesti, 11 Jun. 1940 [P]. – The species occurs also in Senegal (*Monod 15811*, Oued Aguem, Adzan, 2 Dec. 1975 – [P n.v.]) and Lybia.

(5) ***Lotus tibesticus*** Maire, Bull. Mus. Hist. Nat. Paris, ser. 2, **4**: 906 (1932). – Original material (holotype?): *Tilho s.n.*, [Chad] Volcan de l'Emi-Koussi (Tibesti), Bédéoudi, 1912–1917 [P-00373891!].

Perennial herb. Most leaves longer than stem internodes. Leaves pinnate, with five leaflets and conspicuous black glandular stipules. Leaf rachis about 2 mm long, shorter than basal leaflets. Basal leaflets 3–7.5 mm long, with maximum width in the middle of a leaflet or slightly below or slightly above of the middle, equally or slightly unequally sided, elliptic or (ob)ovate to (ob)lanceolate. All three distal leaflets attached to the top of the rachis. They are slightly longer than basal leaflets and with maximum width in the upper part of a leaflet. Stems with more or less curved, patent or almost appressed hairs. Umbel peduncles 1–3 times longer than their subtending leaves. Sterile bract shorter than the calyx, with 1–4 leaflets. Umbels 1–2-flowered. Flower-subtending bracts as well visible dark glands similar to stipules of foliage leaves. Pedicels 1–2 mm long. Calyx 6.5–9 mm long, slightly monosymmetric, teeth slightly longer than the tube. Calyx tube and teeth outside with more or less patent hairs, teeth also with with appressed hairs inside. Petals glabrous, 9–11 mm long. Anthetic petals yellow with red keel tip; postanthetic corolla red. Wings not adhering together in their distal parts. Keel tip straight. Stylodium 5–7 mm long, tooth always present, glabrous. Ovary glabrous or with hairs along the ventral slit only. Fruit straight, not or slightly constricted between seeds, about two times longer than the calyx.

Examined specimens: **Chad**: *Rossetti 73*, Tibesti region, Toussidé, 3000 m, 17 Sep. 1958 [BM]; *Tilho s.n.*, Tibesti, Volcan de l'Emi-Koussi, Bédéoudi, 1912–1917 [P].

(6) *Lotus assakensis* Brand, Bot. Jahrb. Syst. **25**: 199 (1898). – Lectotype (designated by Mader & Podlech 1989, Mitt. Bot. Staatssaml. München **28**: 534): *Mardochèe s.n.*, Assaka, 1875 [P!, isolectotype G, K!, MPU].

= *Lotus ifniensis* Caball., App. Disc. Apert. Curso Acad.: 1 (1936). ≡ *Lotus chazaliei* H. Boissieu var. *ifniensis* (Caball.) Maire, Bull. Soc. Hist. Nat. Afrique N. **30**: 339 (1939). – Lectotype (see Mader & Podlech 1989, Mitt. Bot. Staatssaml. München **28**: 535): *Caballero s.n.*, in arenosis maritimis prope Sidi Ifni, Jul. 1934 [MA].

Perennial herb or half-shrub. Leaves shorter than stem internodes (at least in main shoots), sessile, pinnate or almost palmate, with five leaflets. Stipules not detectable. Leaflets on short petiolules up to 0.6 mm long. Leaf rachis considerably flattened, up to 1 mm wide, up to 2 mm long, much shorter than basal leaflets. Basal leaflets (1.5)2–7 mm long, with maximum width in the lower part of a leaflet, typically ovate or orbicular and more or less unequally sided. All three distal leaflets attached to the top of the rachis. Distal leaflets longer than or as long as basal leaflets, (2)3–9 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stems and leaves with dense indumentum of straight patent hairs; stem surface usually not visible between hairs. Shoots without clear differentiation into distal zone with lateral umbels and proximal zone with paracladia (or innovation shots). Additional buds in any node of the main shoot may give rise to shoots repeating structure of the main shoot. Umbel peduncles 2–5 times longer than their subtending leaves. Sterile bract shorter than the calyx, with (2)3 leaflets and shortened rachis. Umbels 1–6-flowered. Flower subtending bracts present as small dark glands. Pedicels 1–2 mm long. Calyx 5–9 mm long, monosymmetric, but almost not two-lipped. Teeth longer or shorter than the tube. Upper teeth wider than and longer than or as long as lower ones. Calyx tube and teeth with more or less patent hairs outside; teeth also with appressed hairs inside. Petals yellow, standard often with red strips inside. All petals glabrous (except *Fernandez Casas & Molero 13699*, which has standard with some hairs on the outer surface), of almost the same length or wings shorter than keel and standard. Wings 8–12 mm long and (2)2.5–3.5(4.5) mm wide, usually not adhering together in their distal parts. Keel 9–13 mm long, tip straight. Stylodium 5.5–7 mm long, tooth always present, glabrous, 0.2–0.7 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 2.5–4 times longer than the calyx.

Examined specimens: **Morocco**: *Ait Lafkih et al. 819*, 40 km NW from Agadir, on coast road to Essaouira, 4 km N of Cap Rhir lighthouse, 30°40'N, 9°53'W, 20 m, 21 Jul. 1989 [RNG]; *Anonymous (Reading Univ./ BM Exped.) 351*, 40 km S of Agadir, estuary of Oued Massa, 30°10'N, 9°45'W, 5 m, 6 Jun. 1974 [RNG]; *Damblon 84/40*, Prov. Agadir, Tamri, 6 Dec. 1984 [MA]; *Davis 53754*, dist. Tiznit, near mouth of Oued Massa, 5–10 m, 27 Mar. 1972 [RNG]; *Davis 53947*, between Tamri and cap Rhir, 20 m, 1 Apr. 1972 [RNG]; *Fernandez Casas & Molero 13699*, Tarfaya – Tan-Tan, prope Sabkhat Tazgha, 20 m, 30 Apr. 1992 [RNG]; *Fernandez Casas & Susanna 8738* and *s.n.*, Safi, junto a Tamri, 30°43'N, 9°50'W, 13 Oct. 1984 [AD, RNG];

Lewalle 11113, Tiznit, Aglon, 10 m, 25 Oct. 1984 [RNG]; *Mardochèe s.n.*, Assaka, 1875 [P, K]; *Merxmüller & Oberwinkler 22414*, Haha: Hauptstrasse zwischen Essaouira (Mogador) und Agadir entlang der Küste nordlich Cap Rhir, 50 m, 12 Apr. 1967 [M]; *Miller et al. 566* and *572*, 18 km W of Tiznit, Sidi Moussa d'Aglou, 29°8'N, 9°8'W, 5 m, 3 Apr. 1972 [RNG]; *Perring s.n.*, Massa, 3 Apr. 1993 [RNG]; *Podlech 48679*, N'Rand der Sebkha Tah, 3 km E der Hauptstrasse von Tarfaya nach Layoune, 6 km NE Tah, ca. 30 m, 28 Mar. 1990 [M]; *Podlech 48712*, Oued-ez-Zehar, ca. 67 km WSW Tan-Tan-Plage an der Strasse nach Tarfaya, ca. 10 m, 29 Mar. 1990 [M]; *Schuhwerk 90/319* and *90/320*, 7 km SW Akhjfennir, Sebkha N der Strasse P 41 von Tan-Tan nach Tarfaya, 28 Mar. 1990 [M].

(7) ***Lotus pseudocreticus*** Maire, Weiller & Wilczek, Bull. Soc. Hist. Nat. Afrique N. **26**: 120 (1935). – Holotypus: *Maire & Wilczek s.n.*, in arenosis ad oustium fluminis Sous, 2 Apr. 1934 [P!].

Perennial herb or half-shrub with erect or prostrate shoots. Leaves shorter than stem internodes (at least on long shoots), sessile, pinnate, with five leaflets. Stipules not detectable. Leaflets on short petiolules up to 0.7 mm long. Leaf rachis considerably flattened, up to 1.5 mm wide, 0.5–2 mm long, much shorter than basal leaflets. Basal leaflets (1.5)2–7 mm long, with maximum width usually in the lower part of a leaflet, typically ovate (less often elliptic or orbicular) and more or less unequally sided. All three distal leaflets attached to the top of the rachis. Distal leaflets usually longer than or as long as basal leaflets, 2.5–11 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stems and leaves with dense indumentum of straight appressed hairs; stem surface not visible or rarely visible between hairs. Shoots without clear differentiation into distal zone with lateral umbels and proximal zone with paracladia (or innovation shoots). Additional buds in any node of the main shoot may give rise to shoots repeating structure of the main shoot. Umbel peduncles (2.5)4–6 times longer than their subtending leaves. Sterile bract shorter than or as long as the calyx, with 1–3 leaflets and shortened rachis. Umbels 1–6-flowered. Flower subtending bracts usually present as small dark glands. Pedicels 1–2 mm long. Calyx 7–8 mm long, pronouncedly monosymmetric and only slightly two-lipped. Teeth slightly longer to slightly shorter than the tube. Upper teeth longer and wider than lower ones. Calyx tube and teeth with straight appressed or almost patent hairs outside; teeth also with appressed hairs inside. Petals yellow with red veins on the inner side of the standard. All petals glabrous, of almost the same length (or wings slightly shorter than other petals), 10–14 mm. Wings 2.5–3.5 mm wide, usually adhering together in their distal parts. Keel tip straight. Stylodium 6–8 mm long, tooth present, 0.5–0.7 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 1.5–4 times longer than the calyx.

Examined specimens: **Morocco**: *Damblon 84/40*, Tamri, 6 Dec. 1984 [MA, RNG]; *Davis 53484*, Agadir, 2–10 m, 18 Mar. 1972 [RNG]; *Lewalle 13958,* Cap Rhir, 30 Apr. 1994 [AD]; *Maire & Wilczek s.n.*, in arenosis ad oustium fluminis Sous, 2 Apr. 1934 [P]; *Podlech 45715*, Mündung des Oued Sous, Nordufer, ca. 10 m, 2 May 1989 [M]. – Maire (1939) also reported the species from W. Sahara (Rio de Oro).

(8) ***Lotus creticus*** L., Sp. Pl.: 775 (1753). – Lectotype (designated by Heyn & Herrnstadt 1968, Kew Bull **21**: 307): Herb. Clifford No. 372.10 [BM-000646731!].

= *Lotus commutatus* Guss., Fl. Sicul. Prodr. **2**: 545 (1828–1832). – Lectotype (designated by Heyn & Herrnstadt 1968, Kew Bull **21**: 301): *Gussone s.n.,* [Sicily], Trapani nell Isola del Ronciglio, Maggio [NAP].

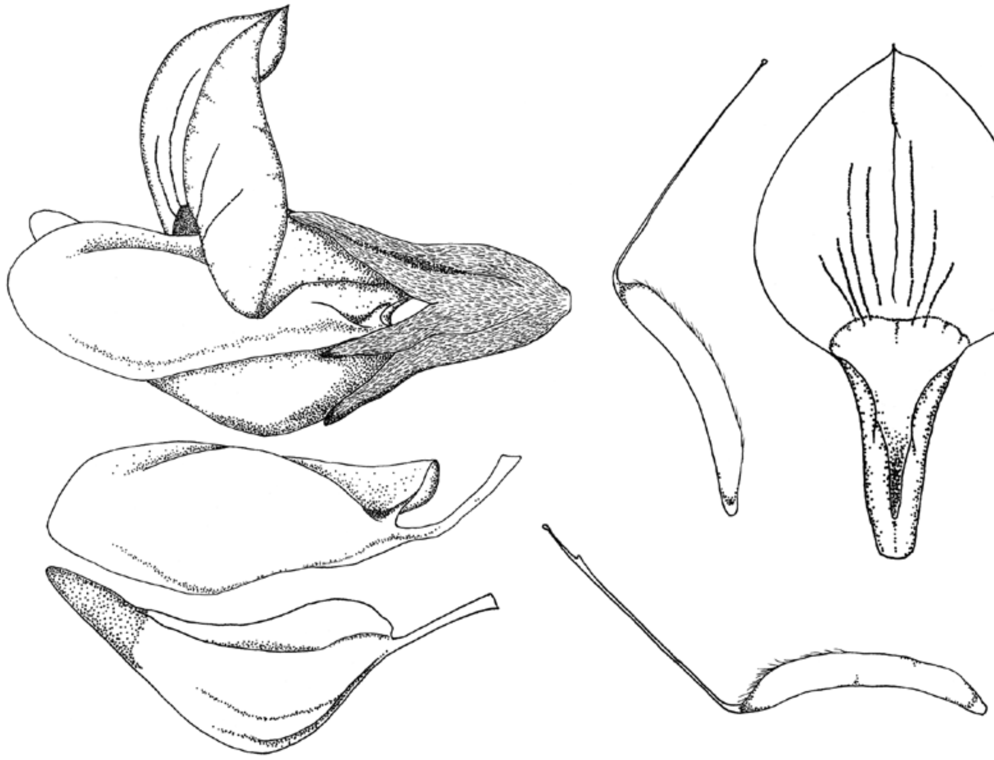

Figure 12: Flower morphology (magnification 5:1). *Lotus creticus* (*Sandral et al. SA-39213*).

= *Lotus salzmannii* Boiss. & Reuter, Pugill. Pl. Afr. Bor. Hispan.: 37 (1852). – Protologue: "Hab. circa Tingidem in arena maritima (Salzm.! Boiss et Reut.), circa Gades (herb. Fauché, Bourgeau pl. exs. 1849, n. 139)"; Syntype: *Bourgeau 139*, Santa Cathalina près Puerto Santa Maria, 8 Mar.1849 [K!, LE!].

Illustrations: figures 7 C, 8 C, 9 D–E, 10 C, 12.

Perennial herb or half-shrub with erect or prostrate shoots. Adventitious roots on shoots absent. Leaves shorter than or longer than stem internodes, sessile, pinnate or almost palmate, with five leaflets. Stipules not detectable in some specimens but present in others as filiform dark structures about 0.5 mm long. Leaflets on short petiolules 0.5–0.8 mm long. Leaf rachis considerably flattened, up to 3 mm wide, 1–5 mm long, much shorter than basal leaflets. Basal leaflets 3–15 mm long, with maximum width usually in the lower part of a leaflet, typically lanceolate or ovate (less often elliptic) and more or less unequally sided. All three distal leaflets attached to the top of the rachis or rarely one leaflet attached below two other leaflets. Distal leaflets longer than or as long as basal leaflets, 4–21 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stems and leaves with dense indumentum of straight appressed hairs; stem and leaf surface usually not visible between hairs. Shoots with a proximal zone bearing branches repeating structure of main shoot, then a node or several nodes bearing axillary umbels, and then typically this pattern repeating again one or several times. Additional buds in any node of the main shoot may give rise to shoots repeating structure of the main shoot. Umbel peduncles 1–8 times longer than their subtending leaves. Sterile bract shorter than to slightly longer than the calyx, with (2)3 leaflets and shortened rachis. Umbels (1–)2–6(–7)-flowered. Flower subtending bracts not detectable or present as very small dark glands about 0.05 mm wide and 0.1 mm long. Pedicels 1–2 mm long. Calyx 7–9 mm long, monosymmetric, pronouncedly two-lipped. Both calyx lips as long as or longer than the tube. Upper lip as long as or slightly longer than the lower lip. Lateral teeth of the lower lip often shorter than the median tooth. Calyx tube outside, and teeth outside and inside with dense indumentum of appressed hairs. Preanthetic and anthetic petals yellow with red veins on the inner side of the standard and with brownish keel tip. Postanthetic petals often brownish-yellow. All petals glabrous, of almost the same length (or standard slightly longer than other petals), 11–17 mm. Wings 3–4.5 mm wide, usually adhering together in their distal parts. Keel tip straight. Stylodium 6–7.5 mm long, tooth absent or very small, scarcely visible. If the tooth is present, it is glabrous. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 2–6 times longer than the calyx.

Selected examined specimens: **Azores** (Portugal): Terceira: *Drouet s.n.*, 1868 [BM]; *Hochst 81*, May 1838 [LE]; *Sandral et al. SA-39212* and *SA-39213*, 38°43.942' N, 27°03.221' W, 52 m, 3 Aug. 2002 (seeds), cultivated in Perth (plots 236 and 253) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39207*, 38°43.597' N, 27°03.697' W, 10 m, 3 Aug. 2002 (seeds), cultivated in Perth (plot 282) and pressed in 2006 [K, MW]. – **Portugal**: *Bourgeau 1840,* Lagos, Algarve, 7 Nov. 1853 [K]; *Brummitt & Ernst 5845*, Prov. Estremadura, Nazaré, 26 Apr. 1967 [K]; *Daveau 3743*, ins. Pecegueiro, Apr. 1886 [BM]; *Daveau 3743*, Praia das Maçãs May 1882 [BM]; *Daveau s.n.*, Trafaria, Apr.–May. 1892 [BM, LE]; *Daveau s.n.*, Trafaria, Sep.–Oct. 1877 [LE]; *Davis 50959*, Sagres – by school of Henry the Navigator (Algarve), 100–200 m, 1 Apr. 1971 [BM]; *Fernandes & Sousa 3081*, Sines, 13 Apr. 1949 [BM]; *Goltz de Carvalho 1963*, Buarcos, 2 May 1885 [BM]; *Langsdorf s.n.*, 1803 [LE]; *Lousley s.n*, Algarve, near Lagos, 5 May 1969 [BM]; *Matos & Matos 11465*, Cascais, Boca do Inferno, 25 May 1971 [MHA]; *Matos & Matos s.n.*, Figueira da Foz, Gala, 11 May 1950 [MHA]; *Murray s.n.,* below Collares, 26 Jun. 1889 [BM]; *Pankhurst 78/46*, Monte Estoril, 10 Apr. 1978 [BM]; *Simon 70-523*, Prov. Algarve, westlich der Ortschaft Vila Real de S.Antonio, 26 Apr. 1970 [MHA]; *Welwitsch 390,* prope Cabo da Rocca, Jun. 1841, Apr. 1840, Jun. 1842 [LE]; *Welwitsch 595*, Prov. Transtagana, 1848 [BM, LE]; *Zuqte d'O. Simões 1234* and *9742*, Peniche, May 1886 [BM]. – **Spain**: *Akeroyd et al. 105*, Valencia, El Saler, 8 km of Valencia, 5 m, 23 Apr. 1982 [BM]; *Alston 10338*, Cadiz, Cadiz Isthmus, sea level, 18 Apr. 1951 [BM]; *Bourgeau 139*, Santa Cathalina near Puerto Santa Maria, 8 Mar. 1849 [BM, LE]; *Bourgeau 1732*, Cabo de Santa Pola près Alicante, 7 May 1852 [LE]; *Brinton-Lee 502*, Andalucia, Tarifa, 0 m, 18 Mar. 1957 [BM]; *Cannon 3418*, Cadiz, 1.5 km NW of Rota, 1 Aug. 1968 [BM]; *Glanville 200*, Almeria, Llanos de Almeria, 29 Apr. 1960 [BM]; *Hillward 76* and *111*, Rota, 6–20 Apr. 1968 [BM]; *Jury 13131*, Cadiz, SW of Vejer de la Frontera, 10 m, 25 Dec. 1993 [BM]; *Miles et al. 421*, Almeria, near El Cabo de Gata, 0.5 km SE of town, 20 Apr. 1980 [BM]; *Porta & Rigo 82*, Alicante, Cabo de S.Pola, 3–8 m, 10 May 1891 [BM, LE]; *Rivas-Martínez et al. 14192,* Prov. Huelva, Punta Umbría, 5 m, 11 Jun.1988 [MHA]; *Salzman s.n.*, Motril, Mar 1825 [LE]; *Simpson 51658*, Playa del Saler, Valencia, 10 May 1951 [BM]; *Simpson 55172*, Gadiz, 18 Apr. 1951 [BM]. – **Gibraltar**: *Broussonet 9* [BM]; *Meinerzhagen s.n*, Mar. 1930 [BM]; *Salzman s.n.*, May 1825 [LE]. – **Italy**, Sicily: *Huet du Pavillon s.n.*, insula del Ronciglio, 15 Apr. 1855 [K, LE]; *Todaro s.n.*, Trapani, May 1828 [BM, K]. – **Greece**, Kos: *Brenan 11115*, Agios Stephanos near Cephalos, 11 Apr. 1971 [K]; *Davis 40525*, Kephalos, near Basilica, 28 Mar. 1965 [K]. – **Lebanon**: *Aucher-Eloy 1239*, "Libano" [K]. – **Israel**: *Anonymous SA-37655*, *SA-37656, SA-37659* and *SA-39319* (seeds), cultivated in Perth (plots 293, 322, 334 and 372) and pressed in 2006 [K, MW]; *Bornmüller 483*, Haifa, 16 Mar. 1897 [K, LE]; *Crawford SA-2318*, Sand Dune Nursery S.C.S. Kiryat Shmuel, 17 May 1967 (seeds), cultivated in Perth (plot 279) and pressed in 2005 [K, MW]; *Eig et al. s.n.*, Ashgelon, 27 Apr. 1927 [LE]; *Pastuchov 15*, *227, 228,* Jaffa, 1 and 2 Apr. 1914 [LE]; *Pastuchov 172,* Haifa, 28 Apr. and 11 May 1914 [LE]; *Zohary & Hen 70*, Tel-Aviv, 26 Mar.1928 [BM, K, LE, MHA]. – **Egypt**: *Ibrahim et al. s.n.*, Rosetta, 19 Apr. 1973 [AD, LE]; *Mashaly & Boulos 20208*, near Maqsaba, north of Lake Borullos, 21 May 2003 [K]; *Simpson 4784*, El Giddiya, Rosetta, 25 Apr. 1927

[K]. – **Morocco**: *Anonymous (Reading Univ./ BM. Exped.) 101*, WS Cap Beddouza, cliffs to N of lighthouse, 32°45' N, 9°15' W, 30 m, 1 Jun. 1974 [BM]; *Ball s.n.,* prope Tanger, 18 Apr. 1871 [LE]; *Bebbing s.n.*, Massa, 3 Apr. 1993 [RNG]; *Davis 48351*, Essaouira (Modagor), 2 m, 18 Mar. 1969 [BM]; *Davis 53941*, between Tamri and Cap Rhir, 20 m, 1 Apr. 1972 [BM]; *Davis 54166*, Cap Beddouza (N of Safi) 50–100 m, 7 Apr. 1972 [BM]; *Davis 54247*, 10 km N of Oualidia, sea level, 8 Apr. 1972 [BM]; *Ferguson et al. 6637/95*, Kenitra, Mehdia, 34°14' N, 6°40' W, 5 m, 3. Jun. 1995 [K]; *Font Quer 349,* El Araix (Laraix), 23 Mar. 1930 [MA]; *Font Quer 810174,* El Araix (Laraix), 35°10' N, 6°10' W, Jun. 1930 [MA]; *Jury et al. 14303*, 46 km NW of Agadir, main road to Essaouira, 4 km N of Cap Rhir lighthouse, 30 m, 18 Mar. 1994 [BM, K]; *Kirkbride et al. 5913*, 4 km S of Aïn Diab on highway 1021, SW of Casablanca, 15 m, 23 Jun. 1989 [K]; *Kirkbride et al. 5984*, Prov. Larache, Plage Larache Rass Ermel, 1 km NE of the mouth of Oued Loukos, near Larache, 10 m, 29 Jun. 1989 [K]; *Lewalle 11294*, Temara, 10 Mar. 1986 [MHA]; *Lewalle 13885*, Rabat, 10 m, 20 Mar. 1993 [MHA]; *Lynes 51*, Agadir, 9 May (presented 1924) [BM]; *Podlech 52358*, Prov. Essauoira, ca. 4 km S Diabat, 30 m, 1 Apr. 1995 [M]; *Prendergast HDVP222*, Prov. Agadir, Reserve Biologique Permanente de Massa, 30°05' N, 009°40' W, 40 m, 10 Jun. 1990 [K]; *Prendergast SA-34273*, Reserve Biologique Permanente de Massa, 10 Jun. 1990 (seeds), cultivated in Perth (plot 235) and pressed in 2005 and 2006 [K, MW]. – **Australia** (naturalized): Victoria: *Albrecht 1577*, Melbourne study area 3 km SW along the Point Lonslade Road from the Queenscliff P.O., 8 m, 17 Feb. 1985 [AD]. – Reported also from Canary Islands (Gomera), France, Malta, Algeria, Tunisia, Lybia (Greuter et al. 1989; Wiersema et al. 1990), but we did not examine specimens from these countries. In many collections specimens of *L. cytisoides* were incorrectly identified as *L. creticus*, so that literature data on distribution of *L. creticus* should be considered critically.

(9) *Lotus chazaliei* H. Boissieu, J. Bot. (Morot) **10**: 220 (1896). – Lectotype (designated by Mader & Podlech 1989, Mitt. Bot. Staatssaml. München **28**: 540): *Comte de Dalmas 4* [Mauritaina], Cap Blanc, banc d'Arguin, 5 May 1895 [P-00373886!, isolectotype P-00373887!, STR].

Perennial herb or half-shrub with rootstock up to 8 mm wide. Leaves shorter or longer than stem internodes, sessile, pinnate or almost palmate, with five leaflets. Leaf rachis up to 1 mm long, shorter than basal leaflets. Basal leaflets 0.8–4 mm long, with maximum width in the lower part of a leaflet, usually ovate. Distal leaflets usually longer than basal leaflets, 1–5.5 mm long, with maximum width in the upper or middle part of a leaflet, obovate, oblanceolate or elliptic. Stems and leaves with dense indumentum of straight appressed hairs; stem surface not visible between hairs. Umbel peduncles 1.5–4.5 times longer than their subtending leaves. Sterile bract shorter than the calyx. Umbels 1–3-flowered. Pedicels 1–1.5 mm long. Calyx 5–8 mm long, clearly or unclearly two-lipped. Teeth shorter than or longer than the tube. Petals yellow. Standard with some hairs on the outer surface, other petals glabrous. Wings shorter than other petals, 6–8 mm long. Keel 7.5–10 mm long, tip straight. Stylodium 4.5–5.3 mm long, tooth present, 0.2–0.3 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 1–2.5 times longer than the calyx. (Description is based on Mader & Podlech 1989 and the two specimens studied here).

Examined material: **Mauritaina**: *Comte de Dalmas 4*, Cap Blanc, banc d'Arguin, 5 May 1895 [P]. – The species occurs in coastal region in extreme north-west of Mauritania and extreme south-west of W Sahara; there is also a record from extreme south-west of Morocco (Mader & Podlech 1989).

(10) *Lotus loweanus* Webb & Berthel., Phyt. Canar. **2**: 87 (1842). ≡ *Pedrosia loweana* (Webb & Berthel.) R. Lowe, Man. Fl. Madeira **1**: 181 (1862). – Lectotype (designated here): "Herb. Webbianum. *Lotus (Heinekenia) Loweanus* Nob. In apricei insula Portus Sancti" [K-000226711!].

– We have seen an image of a specimen from Webb herbarium in Firenze [FI]. This specimen cannot be selected as a lectotype because it was collected in 1855.

= *Pedrosia porto-sanctana* R. Lowe, J. Bot. (Hooker) **8**: 293 (1856). – Protologue: "In rupestribus maritimis Portûs Sancti vulgatiss.", "Discovered first in 1828". – Orginial material: *Lowe 7*, P[or]to S[an]to. Rocks & fields, Hill sides near the Sea, May 1828 [BM-000056518b, BM-000056519, n.v.]. Possible original material: *Lowe 7*, [Porto Santo] Pico de Concelho, May [18]55 [FI – Herb. Webb. 044686, image seen].

Perennial herb or half-shrub with a rootstock. Leaves shorter or longer than stem internodes. Leaves almost sessile or with a very short petiole up to 0.3 mm, pinnate, with five leaflets. Stipules not detectable. Leaflets on short petiolules up to 0.4 mm long. Leaf rachis flattened, 0.5–0.9 mm wide, 0.5–3(5) mm long, considerably shorter than basal leaflets. Basal leaflets 3–6(9) mm long, with maximum width typically in the lower part of a leaflet, linear to lanceolate, equally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, (5)6–9(13) mm long, with maximum width in the upper part of a leaflet, linear to oblanceolate. Stems and leaves with straight appressed hairs. Stem indumentum dense, with stem surface not visible between hairs. Shoots without clear differentiation into distal zone with lateral umbels and proximal zone with paracladia. Additional buds of axillary serial complexes of main shoot give rise paracladia (or innovation shoots). Umbel peduncles much shorter than their subtending leaves, up to 2 mm long. Sterile bract shorter than calyx, with 1–3 leaflets and shortened rachis. Umbels 1-flowered. Flower-subtending bracts not detectable. Pedicels 0.5–1 mm long. Calyx 7–11(12) mm long, almost polysymmetric; teeth much longer than the tube. Calyx with dense long straight patent hairs outside the tube and the teeth; teeth also with appressed hairs inside. Corolla 10–13 mm long, deep mauve to blackish purple, or white with standard tinged pink (Press & Short 1994). Standard with hairs on the outer surface, other petals glabrous. Keel longer than wings and the standard, with tip straight. Wings 1–2 mm wide, not adhering together in their distal parts. Stylodium often with hairs in its lower part, 5.5–6.5 mm long, tooth glabrous, 0.05–0.2 mm long, sometimes absent. Fruits densely covered by hairs, relatively short (usually as long as the calyx to 2.5 times longer than the calyx), usually with one or several very deep constrictions between seeds (fruit width is typically 0.6–1 mm in the constriction region and 1.5–3 mm in regions with developed seeds).

Selected examined specimens: **Madeira** (Portugal): Porto Santo: *Bornmüller 530*, in Monte do Facho, 100 m, 10 May 1900 [S]; *do Castello de Paiva s.n.*, Porto dos Frades [LISU]; *Lowe 7*, 12 May 1855 [LISU]; *Lowe s.n.* and *7*, first ravine to the E of town, 20 Apr. 1855 [BM, LE]; *Lowe s.n.*, Pico do Concelho, 5 May 1855 [BM]; *Sjögren PS1075*, Fonte de Areia, 75 m, 6 May 1966 [UPS].

(11) ***Lotus macranthus*** R. Lowe, Trans. Cambr. Phil. Soc. **6**: 546 (1838). ≡ *Pedrosia macrantha* (R. Lowe) R. Lowe, J. Bot. (Hooker) **8**: 293 (1856). – Lectotype (designated here): *Lowe 3*, Porto Santo, May 1828 [K-000226704!].

Illustrations: figures 7 D, 8 D, 9 F, 13 A, 14.

Short-living perennial to annual herb with prostrate, ascending to almost erect shoots. Adventitious roots on shoots absent. Leaves shorter to longer than internodes, almost sessile (petiole up to

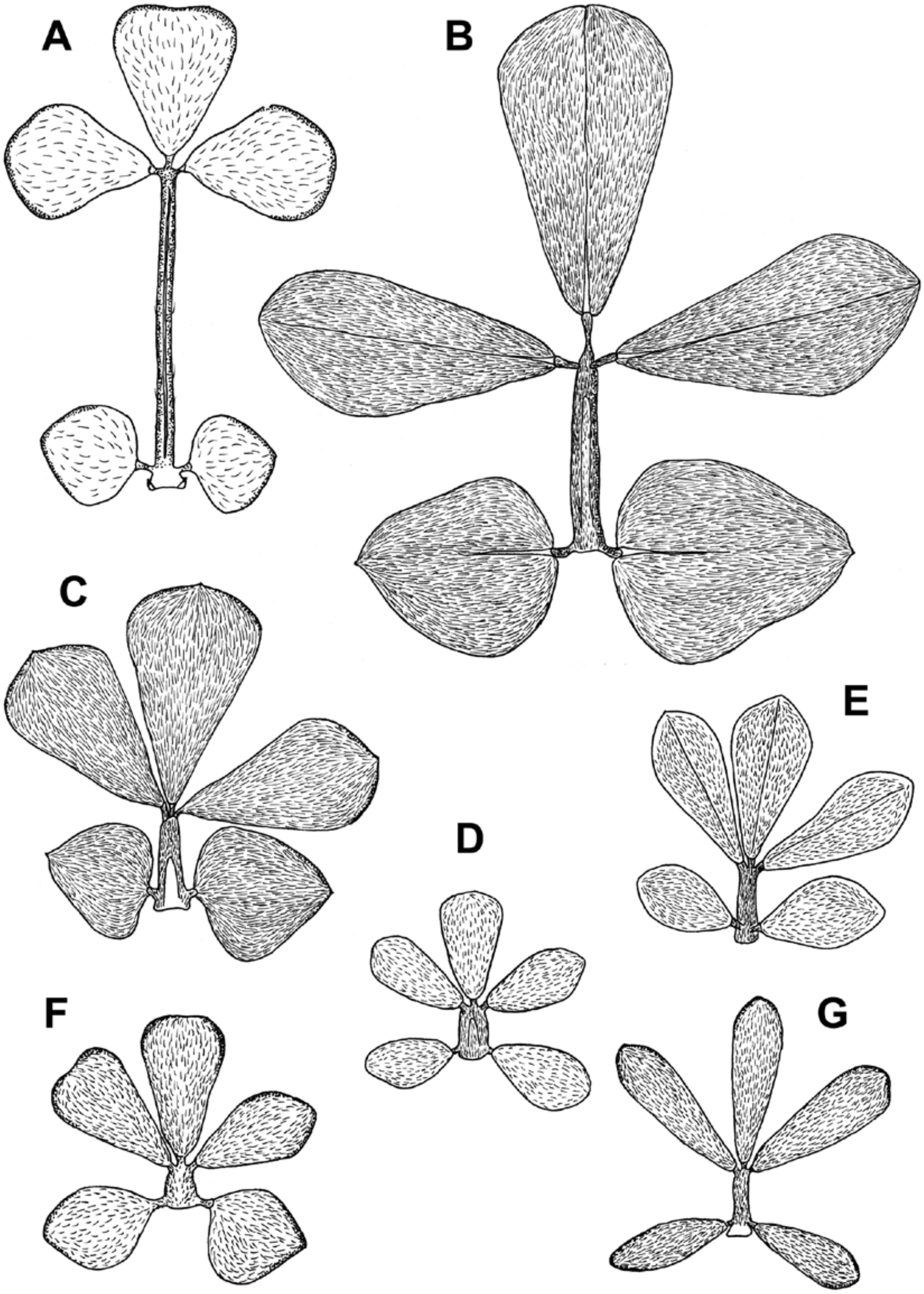

Figure 13: Leaf morphology (magnification 5:1). A, *Lotus macranthus* (*Sandral et al. SA-39120*); B, *Lotus argyrodes* (*Sandral et al. SA-39282*); C, *Lotus lancerottensis* (*Sandral et al. SA-40322*); D *Lotus glaucus* (*Sandral et al. SA-39142*); E, *Lotus dumetorum* (*Sandral et al. SA-40250*); F–G, *Lotus tenellus* (F, *Sandral et al. 04-S6-06-SS*; G, *Sandral et al. SA-39105*).

0.6 mm long), pinnate with five leaflets. Stipules inconspicuous, about 0.15 mm long and 0.3 mm wide, whitish in their proximal part and dark red in distal one. All leaflets on short petiolules about 0.6 mm long. Leaf rachis only slightly flattened, 0.6–0.8 mm wide, (3)5–9(15) mm long, typically twice longer than basal leaflets. Basal leaflets 1–3(8) mm long, with maximum width in the lower or middle part of a leaflet, almost orbicular, broadly ovate or elliptic, equally or unequally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 2–5(12) mm long, with maximum width in the upper part of a leaflet, obovate, broadly obovate or triangular. Stem and leaves with straight appressed hairs about 0.5 mm long. The indumentum is not dense, making general appearance of foliage green. Hairs are usually denser on abaxial than on adaxial leaflet surface. First order shoots bear no axillary umbels. Axillary umbels are present only on shoots of second and higher orders. There is typically a single axillary umbel in a shoot that is attached to its first or rarely second node; long lateral shoots develop in most other nodes. Later usually one to three additional axillary shoots develop in almost each axil of each shoot. Umbel peduncles shorter than their subtending leaves. Sterile bract shorter than calyx, typically with three leaflets, shortly petiolate and with or without a short portion or rachis above insertion of lateral leaflets. Umbels 1-flowered (in one case an abortive 2-flowered umbel was found in axil of sterile bract). Flower-subtending bracts not detectable. Pedicels about 2 mm long. Calyx 7–9 mm long at anthesis and of about the same length in fruits, monosymmetric, and two-lipped. Calyx teeth slightly longer than the tube, those of the upper lip slightly longer and wider than those of the lower lip. Pre-anthetic petals whitish. Anthetic petals mostly (greenish-)white, standard outside and keel tip reddish. Post-anthetic petals purple to violet. All petals glabrous. Standard shorter than the keel. Wings 14–16 mm long, slightly shorter than the keel, 5–6 mm

Figure 14: Flower morphology (magnification 5:1). *Lotus macranthus* (*Sandral et al. SA-39120*).

wide, not adhering together in their distal parts. Keel 15–17 mm long, tip straight. Stylodium 8–9 mm long, tooth always present, glabrous, 0.2–0.3 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous or pubescent throughout the surface. Fruit straight, not constricted between seeds, usually 4 and more times longer than the calyx.

Selected examined specimens: **Madeira** (Portugal): Madeira: *do Castello de Paiva s.n.*, Punta de S. Lourenço [LISU]; *Lemann 8207*, 1837–1838 [RNG]; *Mandon 71*, Cabo Garajau, Feb.–Jun. 1865–1866 [K, Z]; *Menezes s.n.*, Sitio do Garajau, 1923 [LISU]; Porto Santo: *Bornmüller 532*, Pico Facho, 500 m, 10 May 1900 [Z]; *Lowe s.n.* and *3*, May 1828 [K, RNG]; *Lowe 3*, N.W. end of Porto Santo, 4 Jun. 1832 [LISU]; *Lowe,* "Porto Santo 11/32" [K, LISU]; *Lowe 3*, Summit of P[ico] de Facho, 14 May 1855 [LE]; *Lowe 3*, Summit of P[ico] de Facho, 16 May 1855 [K]; *Sandral et al. SA-39118, SA-39119* and *SA-39120*, 33°01.498' N, 16°22.767' W, 25 m, 24 Jul. 2002 (seeds), cultivated in Perth (plots 318, 337 and 371) and pressed in 2005 and 2006 [K, MW].

(12) ***Lotus argyrodes*** R.P. Murray, J. Bot. **35**: 386 (1897). ≡ *Pedrosia argentea* R. Lowe, J. Bot. (Hooker) **8**: 293 (1856). – Lectotype (designated here): *Lowe 3x* [Madeira, Porto Santo] Summit of P[ico] de Facho, 16 May 1855 [K-000262738!, isolectotype BM-000083224b!].

= *Lotus azoricus* P.W. Ball, Feddes Repert. **79**: 40 (1968). – Holotype: *Hunt s.n.*, Azores, St. Mary's, 1848 [K!].

Illustrations: figures 7 E, 8 E, 13 B.

Short-living perennial (or biennial) herb with prostrate or ascending shoots. Adventitious roots on shoots absent. Leaves shorter to longer than internodes, almost sessile (petiole up to 0.3 mm long), pinnate with five leaflets. Stipules inconspicuous. Leaflets on short petiolules about 0.3–0.8 mm long. Leaf rachis flattened, up to 1.2 mm wide, 2–10 mm long, usually shorter than or as long as the basal leaflets (to slightly longer). Basal leaflets 2–11 mm long, with maximum width in the lower or middle part of a leaflet, almost orbicular, broadly ovate or elliptic, equally or unequally sided. All three distal leaflets attached to the top of the rachis or the rachis is slightly prolonged beyond the insertion of two lateral leaflets. Distal leaflets longer than basal ones, 3–18 mm long, with maximum width in the upper part of a leaflet, obovate. Stem and leaves with straight appressed or rarely patent hairs. The indumentum is dense, making general appearance of foliage silvery. Usually, first order shoots bear no axillary umbels, which arise on (second) third to fourth node of lateral shoots. Other nodes develop long lateral shoots. Later additional axillary shoots may develop in almost each axil of each shoot. Umbel peduncles shorter than their subtending leaves. Sterile bract shorter than calyx, usually of three leaflets, sessile or petiolate, with or without a distinct rachis between lateral in the middle leaflet. Umbels 1-flowered (two-flowered umbels are mentioned in the literature but not observed in the available material). Flower-subtending bracts not detectable. Pedicels about 1–4 mm long. Calyx 7–15 mm long, monosymmetric and slightly two-lipped. Teeth longer or shorter than the tube. Upper teeth wider and longer than lower ones. Corolla red or pink, or partially whitish (greenish), 13–25 mm long. All petals glabrous. Standard shorter than or as long as the keel. Wings shorter than or as long as the keel, not adhering together in their distal parts. Keel tip straight. Stylodium 8–11 mm long, tooth always present, glabrous, 0.1–0.2 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous or pubescent throughout the surface. Fruit straight, not or slightly constricted between seeds, usually 3 and more times longer than the calyx.

Examined specimens: **Azores** (Portugal): Santa Maria: *Hunt s.n.*, 1858 [K]; *Sandral et al. SA*-39277, *SA-39281* and *SA-39282*, 36°55.474' N, 25°00.458' W, 0–90 m, 14 Aug. 2002 (seeds), cultivated in Perth (plots 275, 344 and 385) and pressed in 2005 [all – MW], cultivated in Adelaide from seeds collected in Perth (as *SA-43892*) and pressed in 2006 [K, MW]. – **Madeira** (Portugal): Madeira: *Lowe 895*, Ilheo dos Embarcadores, Punta de S. Lourenço, 6 Mar. 1861 [LISU]; *Menezes s.n.*, Punta de S. Lourenço, Apr. 1915 [LISU]; *Sandral et al. SA-39138*, 32°44.564' N, 16°42.013' W, 104 m, 25 Jul. 2002 (seeds), cultivated in Perth (plot 213) and pressed in 2005 and 2006 [K, MW]; Porto Santo: *do Castello de Paiva s.n.*, Pico do Concelho, Jan. 1859 [BM, LISU]; *Lowe 3x*, summit of Pico de Facho, 16 May 1855 [BM, K]; Desertas: *Lowe 831*, 3 Jul. 1849 [K]; *Lowe 895,* 30 May – 2 Jun. 1855 [K, LE]; *Mason s.n.*, 1856 [K]. – Also reported from São Miguel, São Jorge and Pico (Azores).

(13) ***Lotus lancerottensis*** Webb & Berthel., Phyt. Canar. **2**: 84 (1842). – Protologue: "In arenis insularum Lancerottae et Fuerteventurae". – Original material: "42. *Lotus lancerottensis* Nob. In arenosis Lancerottae etiam in Teneriffa" [FI – Herb. Webb. 044674, image seen]. Possible original material (Another annotation on one of these specimens is "Webb 1843". However, it was made by another hand and may not indicate the year when the specimen has been collected.): "*Lotus lancerottensis* Nob. In arenosis Lancerottae" [K-000262747! and K-000226690!].

= *Pedrosia neglecta* Lowe, Man. Fl. Madeira **1**: 172 (1862). ≡ *Lotus neglectus* (R. Lowe) Masferrer, An. Soc. Esp. Hist. Nat. **10**: 159 (1881). – Lectotype (designated here): *Lowe 966*, [Madeira] In cliffs betw[een] Fort St. Jago & the Louros, 1862 [K-000262753!, isolectotype LE!; BM-000056507 has almost the same label].

= *Lotus glaucus* Ait. var. *villosus* Brand, Bot. Jahrb. Syst. **25**: 200 (1898). – Holotype: *Bourgeau 501*, "Fuerteventura, in vervactis circa pagum" [G-BOISS].

Illustrations: figures 7 G–H, 8 F, 9 G, 13 C, 15.

Perennial herb with typically prostrate shoots. Adventitious roots on shoots absent. Leaves much shorter than to almost as long as stem internodes. Leaves sessile, pinnate, with five leaflets. Stipules not detectable or present as very small dark glandular structures, 0.1–0.2 mm long and 0.05 mm wide. All leaflets on short petiolules 0.5–0.8 mm long. Leaf rachis flattened, up to 1.3 mm wide, 1.5–7 mm long, almost as long as or shorter than basal leaflets. Basal leaflets 2–7(8) mm long, with maximum width typically in the lower part of a leaflet, triangular to ovate or orbicular, typically pronouncedly unequally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 4–9 mm long, with maximum width in the upper part of a leaflet, obovate or triangular, less frequently oblanceolate. Stem and leaves with short straight or strongly curved appressed hairs or of straight patent hairs. Stem and leaf indumentum dense or moderately dense, with stem and leaf surface visible or not between hairs. Indumentum densities on adaxial and abaxial leaflet surfaces are alike. Shoots with or without differentiation into a proximal zone bearing paracladia and a distal zone bearing axillary umbels. Additional axillary buds in any part of a shoot typically give rise paracladia. Umbel peduncles typically 1.5–3.5 times longer than their subtending leaves, less often as long as subtending leaves or much longer than subtending leaves. Sterile bract shorter than calyx, typically with three equal leaflets and shortened rachis, rarely with two leaflets or with five leaflets and distinct rachis. Umbels 1–5-flowered. Flower-subtending bracts not detectable. Pedicels 1–2 mm long. Calyx 6–8 mm long at anthesis and of about the same length in fruits, monosymmetric, and two-lipped. Lower calyx

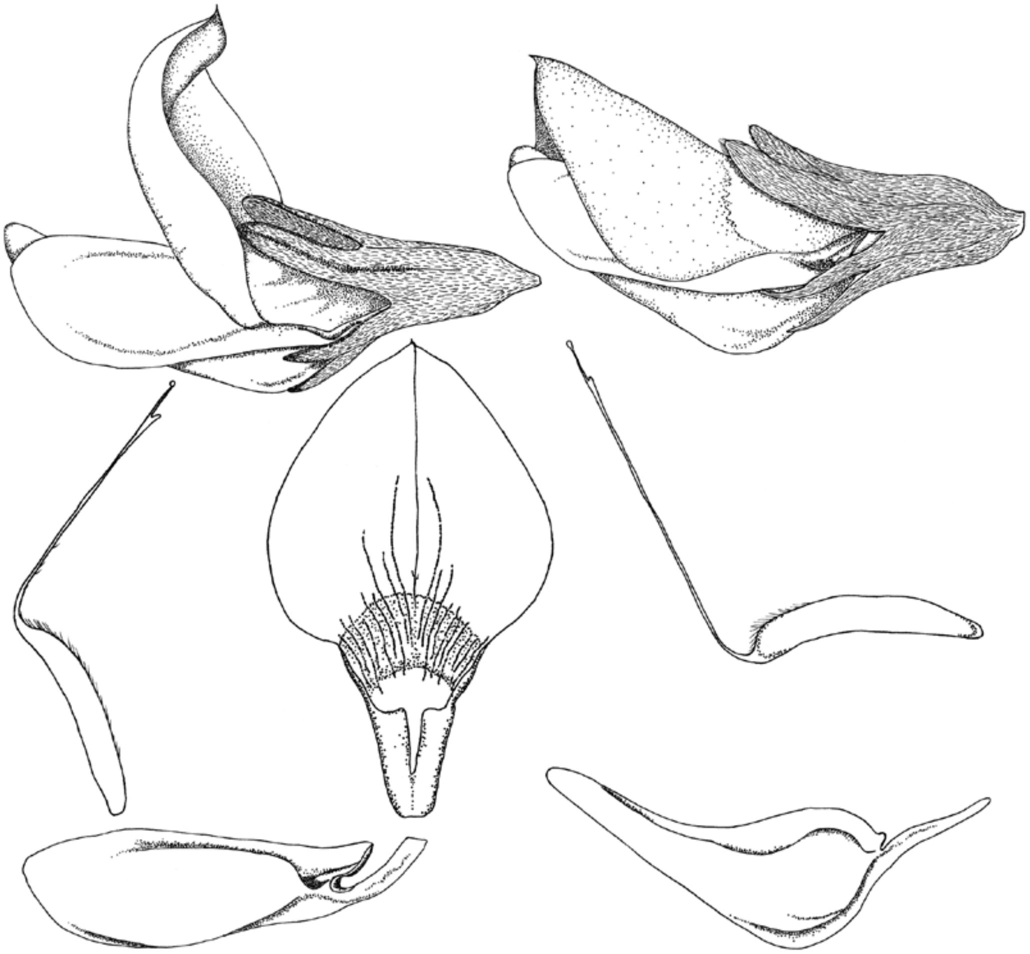

Figure 15: Flower morphology (magnification 5:1). *Lotus lancerottensis* (all dissected petals plus general view and pistil at the left, *Sandral et al. SA-40323*; general view and the pistil at the right, *Sandral et al. SA-40322*).

lip slightly shorter to slightly longer than the tube; upper calyx lip as long as or longer than the tube and longer than the lower lip. Two upper teeth wider than three lower ones. Indumentum similar to that on stem and leaves is present on outer side of the calyx; teeth also with straight hairs inside. Pre-anthetic petals yellow. Anthetic petals yellow; standard often red-veined inside at the base of its blade. Post-anthetic petals may be brownish. All petals glabrous. Standard almost as long as the keel. Wings 8–10 mm long, slightly shorter than the keel, 2.5–4 mm wide, typically not adhering together in their distal parts. Keel 9–11 mm long, tip straight. Stylodium 5.5–6.5 mm long, tooth always present, glabrous, 0.3–0.35 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 2–5 times longer than the calyx.

Selected examined specimens: **Madeira** (Portugal): Madeira: *Lowe 966*, betw[een] Fort St. Jago & the Louros, 1862 [K, LE]; *Mandon 76*, Cabo Garajau, 20 Apr. 1865–1866 [K]; *Sandral et al. SA-39114*, 32°38.813' N, 16°53.567' W, 30 m, 23 Jul. 2002 (seeds), cultivated in Perth (plot 224) and pressed in 2005 [K, MW]. – **Canary Islands** (Spain): Lanzarote: *Breitfeld s.n.*, Suniate, 1968 [M]; *Burchard s.n.*, Los Valles, Mar. 1911 [ORT]; *Burchard 367*, Los Valles, 11 Mar. 1914 [M]; *Lowe 107*, Los Valles on road to Haria, 1 Mar. 1859

[LE]; *Nydegger 26076*, 1 km E Ermita de las Nieves, 480 m, 5 Feb. 1989 [M, MA]; *Raidl s.n.*, Nordspitze der Insel, am Parkplatz zum Mirador del Rio, ca. 400 m, 26 Dec. 1996 [M]; *Sandral et al. SA-40319* and *SA-40320*, 29°09.146' N, 13°29.364' W, 314 m, 21 Jul. 2003 (seeds), cultivated in Perth (plots 255 and 380) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40321* and *SA-40322*, 29°10.600' N, 13°29.807' W, 449 m, 21 Jul. 2003, (seeds), cultivated in Perth (plots 208 and 295) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40323*, 28°59.398' N, 13°37.408' W, 251 m, 21 Jul. 2003 (seeds), cultivated in Perth (plot 225) and pressed in 2005 and 2006 [K, MW]; *Sobrado 65711*, San Bartolome, Jul. 1905 [MA]; *Webb s.n.* [K]; <u>Fuerteventura</u>: *Dorn s.n.*, W Gran Tarajal, 1 km E Matas Blancas, 80–100 m, 18 Feb. 1986 [M]; *Hartung s.n.* [Z]; *Nydegger 26100,* 300 m S Punta de Toston, N Cotiolo, 12 Feb. 1989 [M]; *Sandral et al. 04-S15-15-SS*, 28°26.643' N, 14°02.106' W, 378 m, 1 Jul. 2004 (seeds), cultivated in Perth (plot 361) and pressed in 2005 and 2006 [K, MW].

(14) *Lotus glaucus* Ait., Hort. Kew. **3**: 92 (1789). ≡ *Pedrosia glauca* (Ait.) R. Lowe, J. Bot. (Hooker) **8**: 294 (1856). – Protologue: "Nat. of Madeira. Mr. Francis Masson. Introd. 1777".

= *Pedrosia florida* R. Lowe, J. Bot. (Hooker) **8**: 294 (1856). ≡ *Lotus floridus* (R. Lowe) Masferrer, Anal. Soc. Esp. Hist. Nat. **10**: 160 (1881). ≡ *Lotus glaucus* Ait. var. *floridus* (R. Lowe) Brand, Bot. Jahrb. Syst. **25**: 200 (1898). – Holotype: *Lowe 117*, Porto Santo, hills near the Sea to the E of the town, 2 Jun. 1832 [K-000262752!].

= *Pedrosia florida* R. Lowe var. *sulphurea* R. Lowe, Man. Fl. Madeira **1**: 178 (1862). – Lectotype (designated here): *Lowe 117*, Porto Santo, Pico de Concelho, Zimbral d'Area, 5 May 1855 [K-000262750!].

(14a) *Lotus glaucus* subsp. ***glaucus*.**

Illustrations: figures 7 F, 8 G, 9 H–I, 13 D, 16 (left).

Perennial herb (sometimes suffrutescent) with a rootstock and numerous prostrate shoots forming dense mats. Adventitious roots on shoots absent. Internodes of long main shoots are much longer than leaves, but some lateral shoots can have shorter internodes. Leaves sessile, pinnate (rarely almost palmate), with five leaflets. Stipules not detectable. Leaf rachis up to 2 mm long, much shorter than basal leaflets. Basal leaflets 1.5–4.5 mm long, with maximum width in the upper, middle or lower part of a leaflet, ovate, obovate, elliptic or oblanceolate, equally or slightly unequally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 2–8 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stem and leaves with straight appressed hairs. Hair density differs among specimens. Some plants have dense hairs, so that the stem surface is not visible between them (fig. 7 F) and general appearance of a plant is silvery. Other plants have more sparse (but still straight and appressed) hairs, so that general appearance of a plant is more greenish (fig. 8 G). Shoots usually with a a proximal zone bearing paracladia and a distal zone bearing axillary umbels. The latter zone is often very long; some umbels within this zone can be abortive (then peduncles are small and not developing mature flowers but still possessing a sterile bract). Additional buds of serial axillary complexes in the zone of umbels give rise paracladia or – quite often – additional umbels. In material cultivated in Perth, up to four umbels were formed in axil of the same leaf. Umbel peduncles (1)2–3(4) times longer than their subtending leaves. Sterile bract usually shorter than calyx, with 1–3 leaflets and shortened rachis. Umbels 1–3(–5)-flowered. Flower-subtending bracts not detectable or present as small whitish-yellow structures about 0.2 mm

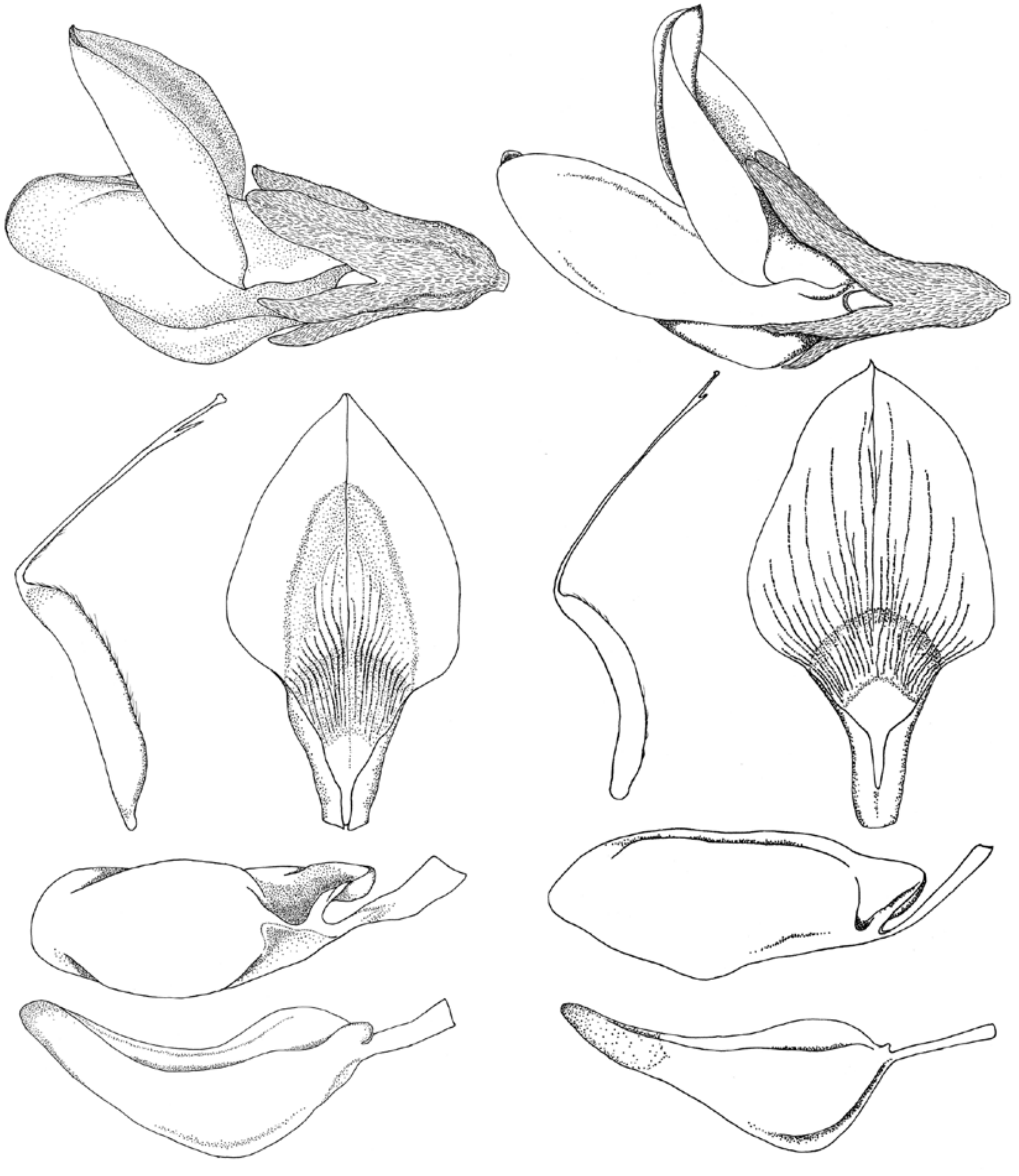

Figure 16: Flower morphology (magnification 5:1). Left: *Lotus glaucus* (*Sandral et al. SA-39129*); right: *Lotus dumetorum* (*Sandral et al. SA-40250*).

long or as small black glandular structures. Pedicels about 1 mm long. Calyx 5–8 mm long, more or less monosymmetric and more or less two-lipped; teeth as long as or longer than the tube. Upper calyx teeth almost as long and as wide as lower ones or much longer and wider than lower teeth. Calyx tube and teeth with appressed hairs outside, teeth also with appressed hairs inside. Anthetic petals orange to reddish, sometimes deep yellow. Post-anthetic petals reddish-brown. All petals glabrous. Standard as long as or shorter than the keel. Wings 9–14 mm long, usually shorter than the keel, 2.5–4 mm wide, not adhering together in their distal parts. Keel 10–15 mm long, tip straight. Stylodium 6–7 mm long, glabrous or with some hairs in its lower part, tooth always present, glabrous, 0.05–0.7 mm long. Ovary and fruit with hairs along the ventral suture, otherwise usually glabrous; sometimes apart from the ventral suture there are also some hairs along the dorsal midvein; rarely some hairs are present also on fruit valves. Fruit straight, not or slightly constricted between seeds, 2–5 times longer than the calyx.

Selected examined specimens: **Madeira** (Portugal): Madeira: *Bornmüller 534*, Funchal prope Gurgulho, 24 Mar. 1900 [LE, Z]; *do Castello de Paiva s.n.* [LISU]; *Favrat 3*, Ponta da Cruz est de Funchal, Nov. 1887 [Z]; *Fischer 60*, 1849 [LE]; *Fritsch s.n.*, 1862 [Z]; *Hertel 33332*, Santa Cruz, near Punta do Oliveira, Coniço de Baixo, 20–50 m, 27 Aug. 1986 [M]; *Hillebrand s.n.*, 15 Jul. 1877 [Z]; *Hillebrand s.n.*, near Fraya formosa, Gurgulho, W. of Funchal, Dec. 1897 [Z]; *Hochst 80*, Aug. 1858 [LE]; *Holl s.n.*, prope Camera dos Loubos, 27 May 1827 [LE, Z]; *Lowe 81*, Ilheo dos Embarcadores, Punta de S. Lourenço, 31 Mar. 1860 [K]; *Lowe 81*, Punta de S. Lourenço, 5 Jul. 1836 [K]; *Lowe 81,* Punta da Cruz, 2–3 Apr. 1860 [LE]; *Mac Gillivray 22*, 29 Jun. 1852 [K]; *Regel s.n.*, [Z]; *Romariz 700/545*, Ilheu do Gorgulla, 11 May 1951 [LISU]; *Sandral et al. SA-39132, SA-39133* and *SA-39134*, 32°44.564’ N, 16°42.013’ W, 104 m, 25 Jul. 2002 (seeds), cultivated in Perth (plots 212, 229 and 376) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39141, SA-39142* and *SA-39143*, 32°51.169’ N, 17°09.026’ W, 12 m, 26 Jul. 2002 (seeds), cultivated in Perth (plots 261, 288 and 289) and pressed in 2006 [K, MW], cultivated in Adelaide from seeds collected in Perth (as *SA 43894*) and pressed in 2006 [K, MW]; *Wängsjö 1212*, Ponta de São Lourenco, ca 2.5 km väster om Piedade, 28 June 1965 [Z]; Porto Santo: *do Castello de Paiva s.n.* [LISU]; *Hartung s.n.* [Z]; *Lowe 117*, Pico de Concelho, 4 May 1855 [K]; *Lowe 117*, Pico de Concelho, Zimbral d’Area, 5 May 1855 [K]; *Lowe 117*, Porto Santo, hills near the Sea to the E of the town, 2 Jun. 1832 [K]; *Lowe 179*, promontory on the N coast called Malhado or Punta de Guilherme, 21 Apr. 1855 [K]; *Mandon 75*, Porto dos Frades, 24 Apr. 1866 [LE]; *Sandral et al. SA-39117*, 33°01’498” N, 16°22’767” W, 25 m, 24 Jul. 2002 (seeds), cultivated in Perth (plot 214) and pressed in 2006 [K, MW]; *Sandral et al. SA-39122*, 33°03.420’ N, 16°22.680’ W, 80 m, 24 Jul. 2002 (seeds), cultivated in Perth (plot 252) and pressed in 2005 [MW]; *Sandral et al. SA-39126*, *SA-39129* and *SA-39130*, 33°04.788’ N, 16°21.603’ W, 167 m, 24 Jul. 2002 (seeds), cultivated in Perth (plots 206, 211 and 280) and pressed in 2005 and 2006 [K, MW].

(14b) *Lotus glaucus* Ait. subsp. ***salvagensis*** (R.P. Murray) Sandral & D.D. Sokoloff, **comb. nova.** ≡ *Lotus salvagensis* R.P. Murray, J. Bot. **35**: 382 (1897). – Holotype: *Grant s.n.*, Grand Piton, May 1895 [BM].

= *Pedrosia paivae* R. Lowe, Fl. Salv. Tent.: 10 (1869). ≡ *Lotus paivae* (R. Lowe) Meneses, J. Cienc. Mat. Fis. Nat. (Lisb.) **23**: 191 (1924). – Lecotype (designated by Monod 1990, Bol. Mus. Municip. Funchal, Supl. **1**: 40): *Noronha s.n.,* Salvagem Gr.[ande], 1863 [K-000226715!, isolectotype BM-000056365].

Differs from subsp. *glaucus* in peduncles, which are usually as long as or shorter than their subtending leaves and in much more variable leaf shape and size. Leaflets often (but not always!) considerably longer than in subsp. *glaucus* (up to 13 mm). Lower leaflets usually with maximum width in the lower part of a leaflet and can be pronouncedly unequally sided. In the latter case, the leaves can approach those of *Lotus creticus* (including their silvery indumentum).

Examined specimens: **Salvage Islands** (Portugal): *Anonymous s.n.*, Grand Piton, 19 May 1953 [ORT]; *Grant s.n.*, Grand Piton, Apr. 1895 [RNG]; *herb. Lowe s.n.*, Little Salvage, May 1869 [K]; *herb. Lowe s.n.*, Salvagem Grande, 1865 [K]; *Noronha s.n.,* Salvagem Gr.[ande], 1863 [K]; *Paiva s.n.*, 1860 [K, LE] – note, the specimens from K and LE are morphologically very different; *Nóbrega & Santos s.n.*, D. Noia, Carlos, Isidoro, 10 May 1983 [LISU]; *Pickering 1735* [K].

(14c) ***Lotus glaucus*** **s.l.** from Fuerteventura

? = *Lotus erythrorhizus* Bolle, Bot. Jahrb. Syst. **14**: 238 (1891). ≡ *Lotus glaucus* Ait. var. *erythrorhizus* (Bolle) Brand, Bot. Jahrb. Syst. **25**: 200 (1898). ≡ *Lotus lancerottensis* Webb & Berthel. var. *erythrorhizus* (Bolle) Kunkel, Cuad. Bot. Canaria **28**: 11 (1977). – Protologue: Fuerteventura, "La punta de Handia, in arena concharum".

We have examined only limited material from Fuerteventura and it is difficult to make a precise decision on its taxonomic identity. Lewis (in sched.) was quite right identifying his specimens (see below) as "*Lotus* aff. *L. lancerottensis* Webb & Berth. and *L. glaucus* Ait.". Indeed, the basal leaflets are unequally sided and widened near the base, as in *L. lancerottensis*. On the other hand, the leaf rachis is very short, as in *L. glaucus*. We believe, that rachis length is more important than basal leaflet shape, because similar basal leaflet shape can also be found in some specimens of *L. glaucus* from Madeira and especially from Salvage Islands. Thus, we incline to identify this material from Fuerteventura as *L. glaucus* s.l. (note, typical *L. lancerottensis* also occurs in Fuerteventura). Peduncles are 2–3 times longer than their subtending leaves, what excludes identification the Fuerteventura material as subsp. *salvagensis*. They could represent a third subspecies of *L. glaucus*.

Lotus erythrorhizus Bolle was described from Fuerteventura and then synonymized by various authors either with *L. glaucus* or with *L. lancerottensis*. We were unable to trace the original material, which could be lost. The description in the protologue is closer to *L. glaucus*. Allan et al. (2004) accepted *L. erythrorhizus* as a distinct species endemic to Fuerteventura; they do not report *L. glaucus* from that island.

Examined specimens: **Canary Islands** (Spain): Fuerteventura: *Lewis s.n.,* Playa Olivia on north of island, 28 Oct. 2003 [K, two specimens]; *Mèndez & Acebes 13662*, Jandia, Playa Esmeralda, 1 May 1981 [K].

(15) ***Lotus dumetorum*** Webb ex R.P. Murray, J. Bot. **35**: 384 (1897). ≡ *Lotus glaucus* Ait. subsp. *dumetorum* (R.P. Murray) Bornm., Bot. Jahrb. Syst. **33**: 443 (1903). – Lectotype (designated here): *Bourgeau 1321*, in rupestribus convallis Bufadero, 9 Apr. 1855 [K-000262756!]. The original material available for this study (*Bourgeau 803, 1321, 1322*) is heterogenous. Namely, *Bourgeau 1322* could be identified as *Lotus dumetorum* × *L. campylocladus*. We designate *Bourgeau 1321* as a lectotype to keep the traditional concept of this species.

= *Lotus arenarius* var. *webbii* Ball, J. Linn. Soc., Bot. **16**: 423 (1878), p.p. – Lectotype: (designated here): *Bourgeau 1321*, in rupestribus convallis Bufadero, 9 Apr. 1855 [K-000262756!].

Illustrations: figures 7 I, 8 H, 9 J, 13 E, 16 (right).

Short-living dwarf shrub or half-shrub with erect, ascending and prostrate shoots forming dense mats up to 1.5 m wide and 0.5 m tall.Adventitious roots on shoots absent. Leaves usually shorter than stem internodes, sessile or with a very short petiole up to 0.5 mm, pinnate, with five leaflets. Stipules not detectable or rarely present as glandular dark structures up to 0.1 mm long. Leaf rachis flattened, up to 0.9 mm wide, (0.5)1–3 mm long, shorter (often more than twice) than basal leaflets. Basal leaflets 2–5 mm long, with maximum width in the upper or middle part of a leaflet, elliptic, obovate or oblanceolate, equally or very slightly unequally sided. All three distal leaflets attached to the top of the rachis. They are usually longer than basal leaflets, 2–7 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stem and leaf indumentum of straight appressed hairs. Stem indumentum dense, with general aspect of stems white. Shoots with a proximal zone bearing nodes with paracladia (or innovation shoots) and a zone bearing axillary umbels; then the pattern often repeats again (a new zone of paracladia, then a new zore of umbels). Additional buds of serial axillary complexes in both parts of main shoot give rise paracladia (or renovation shoots). Umbel peduncles (1)2–5 times longer than their subtending leaves. Sterile bract shorter than calyx, with 1–3 leaflets and shortened rachis, usually with dark glandular stipules. Umbels 1–3(5)-flowered. Flower-subtending bracts usually present as small dark glandular hairy structures 0.1–0.3 mm long. Pedicels 1–4 mm long. Calyx 6–7 mm long, monosymmetric and only slightly two-lipped; teeth usually longer than the tube (up to twice longer) but sometimes as long as the tube; upper teeth usually longer and wider than lower ones, more or less bent upwards. Calyx tube and teeth outside as well as the tube inside with appressed straight hairs that are less dense than on stems. All petals glabrous. Standard almost as long as the keel (10–12 mm), wings shorter than or as long as the keel, 9–11 mm long, 2.5–3.5 mm wide. Keel tip straight. Stylodium 5.5–7 mm long, tooth always present, 0.1–0.3 mm long, glabrous. Ovary and fruit with hairs along the ventral suture only, or almost completely glabrous. Fruit straight, not or slightly constricted between seeds, (1.5)2–4 times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): Tenerife: *Bornmüller 2283*, Taganana, 3–400 m, 30 May 1901 [LE, Z-000046114]; *Bornmüller 537*, Taganana, 200 m, 14 Jun. 1900 [Z]; *Bourgeau 1321*, in rupestribus convallis Bufadero, 9 Apr. 1855 [K]; *Bourgeau 803*, ad rupes Degollada del Bufadero Cumbre Mercedes, 13 Jun. 1846 [K]; *Murray s.n.,* near the top of the Anaga Hills, 19 Jun. 1892 [K]; *Murray s.n.*, Laguna, 18 Apr. 1902 [K]; *Sandral et al. SA-39093*, 28°31.848' N, 16°11.710' W, 680 m, 19 Jul. 2002 (seeds), cultivated in Perth (plot 218) and pressed in 2006 [K, MW]; *Sandral et al. SA-40248*, 28°31.847' N, 16°11.711' W, 263 m, 17 Jul. 2003 (seeds), cultivated in Perth (plot 228) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40250*, 28°32.571' N, 16°11.705' W, 436 m, 17 Jul. 2003 (seeds), cultivated in Perth (plot 382) and pressed in 2006 [K, MW]; *Sandral et al. SA-40251* and *SA-40252*, 28°33.367' N, 16°09.375' W, 650 m, 17 Jul. 2003 (seeds), cultivated in Perth (plots 240 and 277) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40253*, 28°33.604' N, 16°09.583' W, 670 m, 17 Jul. 2003 (seeds), cultivated in Perth (plot 254) and pressed in 2005 [MW]; *Sventenius 15018*, Bailadero de Taganana, 9 Mar. 1966 [ORT].

Lotus dumetorum × *L· campylocladus*

Basically, *L. campylocladus* differs from *L. dumetorum* in curved and/or patent (not straight appressed) stem hairs, leaf rachis longer than in *L. dumetorum* (it is just slightly shorter than to slightly longer than basal leaflets in *L. campylocladus*) and (1–)2–5-flowered umbels. Stem hair type is the most important technical character to distinguish *L. dumetorum*. However, some plants collected near Taganana are generally similar to *L. dumetorum* but have more or less patent hairs. It seems that there is introgression between the two species near Taganana, as almost typical specimens of *L. dumetorum* and *L. campylocladus* have also been collected from the same locality. In fact, the collection *Bornmüller 2283* is mixed, containing both species and putative hybrids, thus indicating that they all grow hand by hand.

Examined specimens: **Canary Islands** (Spain): Tenerife: *Bolle s.n.*, Taganana, 1852 [Z]; *Bornmüller 536*, Taganana, 1900 m, 5 Jun 1900 [Z-000046112]; *Bornmüller 537*, Taganana, 200 m, 14 Jun. 1900 [Z-000046117]; *Bornmüller 2283*, Taganana, 3–400 m, 30 May 1901 [K, LE, M-0089940]; *Bourgeau 1322*, Taganana, 8 May 1855 [MA-65692].

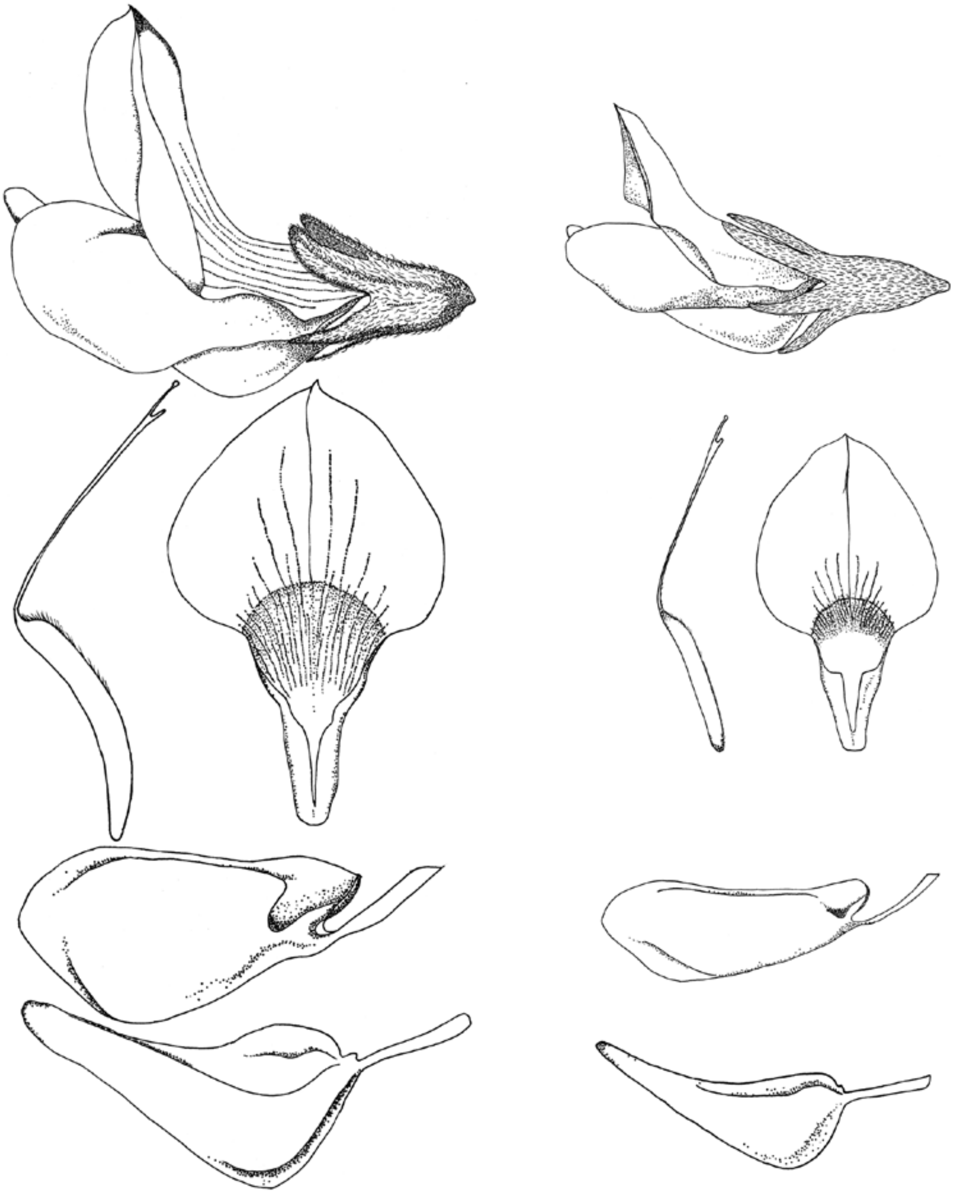

Figure 17: Flower morphology (magnification 5:1). *Lotus tenellus* (left, *Sandral et al. 04-S6-06-SS*; right, *SA-39105*).

(16) *Lotus tenellus* (R. Lowe) Sandral, Santos & D.D. Sokoloff, Wulfenia **13**: 93 (2006). ≡ *Pedrosia tenella* R. Lowe, Man. Fl. Madeira **1**: 177 (1862). – Original material: *Bourgeau 1323*, 1855 [BM].

= *Pedrosia leptophylla* R. Lowe, Man. Fl. Madeira **1**: 177 (1862). ≡ *Lotus glaucus* var. *leptophyllus* (R. Lowe) Bornm., Bot. Jahrb. Syst. **33**: 443 (1903); Pitard, in Pitard & Proust, Iles Canaries: 167 (1908). ≡ *Lotus leptophyllus* (R. Lowe) K. Larsen, Biol. Skr. **11**: 21 (1960), quad typo, non pl. – Lecotype (designated by Bramwell 1995, Bot. Macaronésica **22**: 115): *Lowe s.n.*, [Gran Canaria], hills above Las Palmas, 18 Apr. 1859 [BM, isolectotype – K-000262746!].

= *Lotus glaucus* Ait. var. *angustifolius* R.P. Murray, J. Bot. **35**: 382 (1897). – Lectotype (designated here): *Murray s.n.*, near Gando, 7 May 1894 [K!].

= *Lotus glaucus* Ait. subsp. *sessilifolius* (DC.) Bornm., Bot. Jahrb. Syst. **33**: 443 (1903), p.p., non *Lotus sessilifolius* DC.

= *Lotus glaucus* auct. mult. fl. Canar. non Ait.

Illustrations: figures 7J–K, 8I–J, 9K–L, 13F–G, 17.

Perennial herb or half-shrub with a rootstock and usually prostrate shoots. Adventitious roots on shoots absent. Leaves usually shorter than stem internodes, sessile or with a very short petiole, pinnate, with five leaflets. Stipules usually not detectable. Leaf rachis (0.5)1–2 mm long, shorter (often more than twice) than basal leaflets. Basal leaflets 1–5 mm long, with maximum width in the upper or middle part of a leaflet, elliptic, obovate or oblanceolate (sometimes almost orbicular or – rarely – linear-lanceolate), equally or slightly unequally sided. All three distal leaflets attached to the top of the rachis. They are usually longer than basal leaflets, 2–7 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate (rarely linear-lanceolate). Stem and leaf indumentum of straight appressed to curved patent hairs (sometimes intermediate between these two types). Indumentum moderdately dense, with stem and leaf surface visible between hairs. Shoots usually with a proximal zone bearing nodes with paracladia (or innovation shoots) and a distal zone bearing axillary umbels. Additional buds of serial axillary complexes in the proximal zone of main shoot give rise paracladia (or renovation shoots), whereas in the distal zone they give rise paracladia or umbel peduncles. Umbel peduncles 2–6 times longer than their subtending leaves. Sterile bract shorter than calyx, with 1–3 leaflets and shortened rachis. Umbels 1–3(4)-flowered. Flower-subtending bracts usually absent. Pedicels 1–2 mm long. Calyx 5–7(8) mm long, slightly monosymmetric and only slightly two-lipped; teeth usually as long as the tube but sometimes slightly shorter or up to twice longer than the tube; upper teeth longer and/or wider than lower ones. Calyx tube and teeth outside with appressed to more or less patent and curved hairs; teeth also with appressed straight hairs inside. All petals glabrous. Standard almost as long as the keel (9–14 mm), wings shorter than or as long as the keel, 8–13 mm long, 2–4 mm wide. Keel tip straight. Stylodium 5–7.5 mm long, tooth always present, 0.2–0.5 mm long, glabrous. Ovary and fruit with hairs along the ventral suture only, or rarely also with some hairs on fruit valves. Fruit straight, not or slightly constricted between seeds, 2–5 times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): Tenerife: *Aldridge 1645*, track to Punta de Teno from Buenavista, 29 Apr. 1973 [RNG]; *Asplund 564*, Buenavista, between Casablanca and Teno, 500 m, 27 Mar. 1933 [K]; *Ball s.n.*, Garachico, Mar. 1888 [Z]; *Ball s.n.*, Puerto de Orotava, Feb. 1888 [Z]; *Bornmüller 2282*, Bajamar, 13 Jun. 1901 [LE, Z]; *Bornmüller s.n.*, Bajamar, 13 Jun. 1901 [M]; *Bourgeau s.n.*, Puerto de la Orotava [Z]; *Bramwell 1237*, Montañas de Teno, 250 m, 4 May 1969 [RNG]; *Bramwell 1777*, Montañas de Teno, Barranco de la Cueva above Teno Bajo, 200 m, 13 Jul. 1969 [RNG]; *Bramwell 338*, San Juan de la Rambla, 5 m, 4 Feb. 1968 [RNG]; *Burchard 199*, Bajamar, Jan. 1924 [Z]; *Burchard 44*, Puerto Orotava, Apr. 1904 [M]; *Burchard s.n.*, Puerto Orotava, Mar. 1907 [Z]; *Christ s.n.*, Garachico, May 1884 [Z]; *Christ s.n.*, Puerto Orotava prope castellum, May 1884 [Z]; *Evans 390*, along the road to Teno, ca. 2 km west of Buenavista, 14 May 1979 [Z]; *Fritsch s.n.*, Orotava, May 1863 [Z]; *Heywood & Moore 7*, Punta de Teno, 100 m, 8 Apr. 1976 [RNG]; *Hillebrand s.n.*, below Dehesa near Burgados, 4 June 1880 [Z]; *Hillebrand s.n.*, Dehesa (Orotava), 4 June 1880 [Z]; *Hillebrand s.n.*, Teno near Palmar, 1880 [Z]; *Jarvis & Murphy 181*, Montañas de Teno, beyond road tunnel to Punta de Teno, 50 m, 8 Apr. 1977 [RNG]; *Jarvis & Murphy 187*, Montañas de Teno, W of Buenavista, 50 m, 8 Apr. 1977 [RNG]; *Jarvis 665*, Punta de Teno, beyond road tunnel to Punta de Teno, 50 m, 12 May 1977 [RNG]; *Lems 2635*, Buenavista, El Fraile, 19 Jun. 1956 [RNG]; *Lowe 205*,

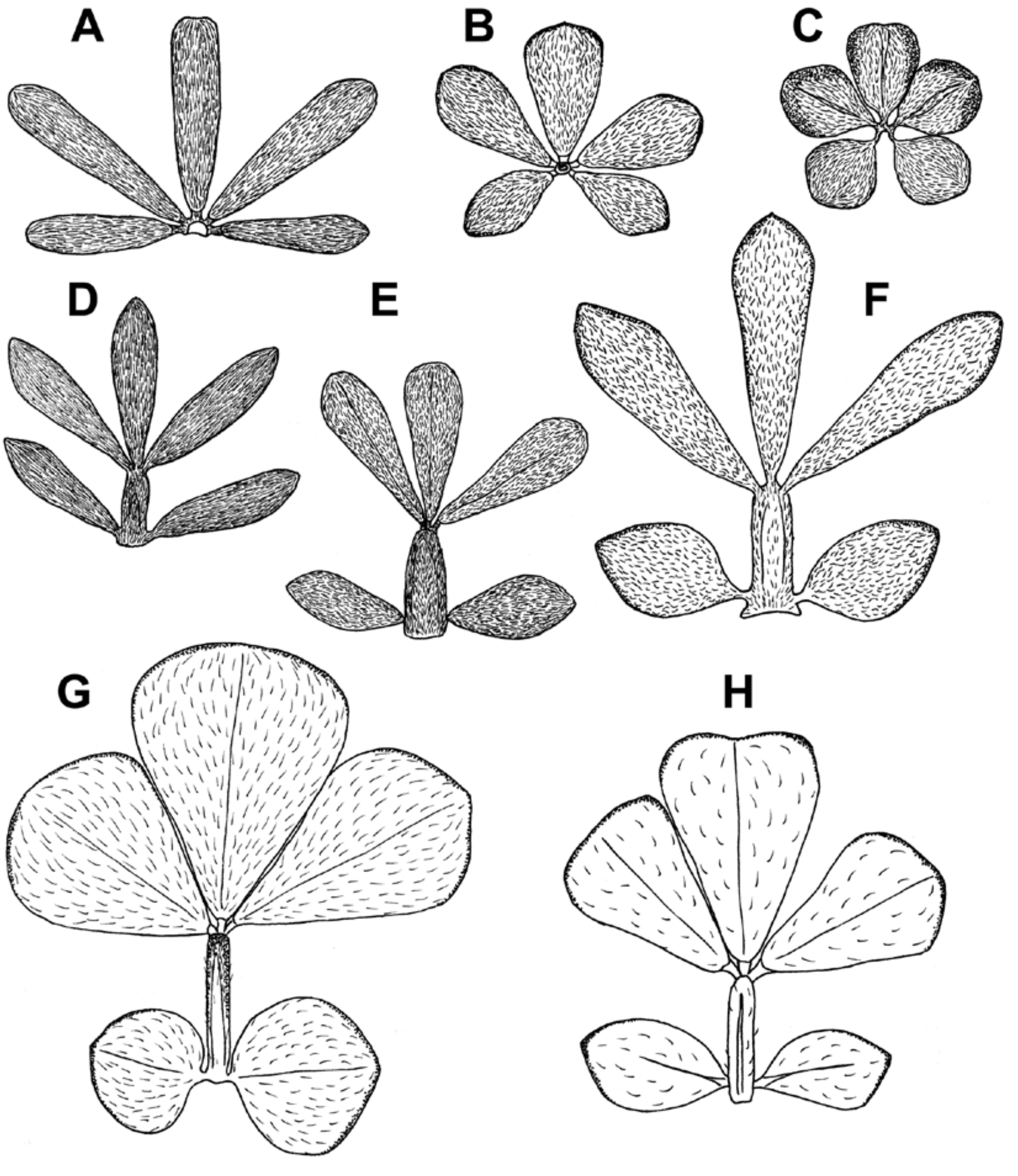

Figure 18: Leaf morphology (magnification 5:1). A, *Lotus sessilifolius* subsp. *sessilifolius* (*Sandral et al. SA-39063*); B, *Lotus sessilifolius* subsp. *villosissimus* (*Sandral et al. SA-40266*); C, *Lotus arinagensis* (*Sandral et al. SA-40278*); D, *Lotus spartioides* (*Sandral et al. SA-40312*); E, *Lotus campylocladus* subsp. *campylocladus* (*Sandral et al. SA-39071*); F, *Lotus campylocladus* subsp. *hillebrandii* (*Sandral et al. 04-S21-21-S*); G, *Lotus emeroides* (*Sandral et al. SA-40305*); H, *Lotus callis-viridis* (*Sandral et al. 04-S10-10-SS*).

between Realejo and San Juan de la Rambla, 14 Jul. 1858 [K]; *Murray s.n.*, Puerto Orotava, 16 Jun. 1894 [K]; *Noll s.n.*, Sept. 1871 [Z]; *Pitard 133*, Tacoronte, 26 Jan. 1905 [Z]; *Sandral et al. 04-S6-06-SS*, 28°22.609' N, 16°48.004' W, 14 m, 14 Jul. 2004 (seeds), cultivated in Perth (plot 207) and pressed in 2005 and 2006 [K, MW]; *Santos & Calero s.n.,* costa del Sauzal, 10 m, 21. Apr. 1983 [ORT]; *Schröter s.n.*, Barranco de las Palmas, 13 Apr. 1908 [Z]; *Schröter s.n.*, Garachico, 3 Apr. 1908 [Z]; *Schröter s.n.*, Puerto Orotava, 12 Apr.

1908 [Z]; *Zednik s.n.*, between Punta Morro del Diablo and Punta de la Gaviota, ca. 5 km W of Buenavista del Norte, 30 m, 7 Jun. 1996 [K]; Gran Canaria: *Aldridge 1587*, Cuesta de Silva, E of Guia, 300 m, 23 Apr. 1973 [RNG]; *Askenasy s.n.*, Apr. 1882 [Z]; *Asplund 14*, Las Palmas, Bahia del Confital, 2 Mar. 1933 [K]; *Bramwell 1172*, below Galdar on N coast, 20 m, 1 Apr.1969 [RNG]; *Bramwell 1228*, below Moya, 100 m, 1 Apr.1969 [RNG]; *Bramwell 3171*, between Agaete and Barranco la Palma, 150 m, 28 Mar. 1971 [RNG]; *Cramer s.n.*, Las Palmas [Z]; *Hillebrand s.n.*, San Felipe, 27 Apr. 1882 [Z]; *Kunkel 12292*, Barranco Seco, 120 m, 11 Jan. 1969 [M]; *Kunkel 14012*, Puerto Aldea, 5 m, 26 Mar.1971 [G]; *Kunkel 14885*, Punta Sardina, 10 m, 12 Apr. 1972 [G]; *Lowe s.n.*, hills above Las Palmas, 18 Apr. 1859 [K]; *Murray s.n.*, Jinámar, 27 Apr. 1894, [K]; *Murray s.n.*, near Gando, 7 May 1894 [K]; *Murray s.n.*, roadside near Guia, 19 May 1892 [K]; *Sandral et al. 04-S09-09-SS*, 28°08.403' N, 15°35.729' W, 164 m, 15 Jul. 2004 (seeds), cultivated in Perth (plot 327) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39098*, 28°03.859' N, 15°27.522' W, 328 m, 20 Jul. 2002 (seeds), cultivated in Perth (plot 321) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39105*, 28°01.007' N, 15°26.311' W, 720 m, 20 Jul. 2002 (seeds), cultivated in Perth (plot 263) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40280*, 28°10.117' N, 15°38.107' W, 20 m, 23 Jul. 2003 (seeds), cultivated in Perth (plot 313) and pressed in 2005 [MW]; *Sandral et al. SA-40281*, 28°10'72" N, 15°38'63" W, 35 m, 23 Jul. 2003 (seeds), cultivated in Perth (plot 256) and pressed in 2005 and 2006 [K, MW]; *Wängsjö 210*, Puerto de las Nieves, 29 June 1963 [Z].

Lotus tenellus × ***Lotus sessilifolius*** subsp. ***sessilifolius***

Lotus sessilifolius subsp. *sessilifolius* differs from *L. tenellus* mainly in palmate leaves (without a rachis). Besides, *L. sessilifolius* subsp. *sessilifolius* has generally more flowers per umbel (up to 6–7); it is also characterized by a tendency to have a gradient in indumentum type within a plant (for example, the calyx can be covered by patent hairs, whereas the stems – or their portions – can be covered by appressed hairs in the same individual). There are also habitual differences between the two taxa that are difficult to describe. The two specimens cited below have a rachis similar to that in *L. tenellus*, but resemble *L. sessilifolius* in other features. Their identification as hybrids is tentative only. They may be just manifestations of variability of either *L. tenellus* or *L. sessilifolius*. The following quotation from Murray (1897: 383) agrees well with our observations: "The leaves of *L. glaucus* var. *angustifolius* [=*L. tenellus*] sometimes hardly differ from those of *L. sessilifolius* except being stalked [=pinnate, i.e., with a rachis], while I have occasionaly, though very rarely, found plants of *L. sessilifolius* with a few of the leaves with a distinct though short petiole [=rachis]". Note, however, that the Murray's specimen listed below belongs to original material of his var. *angustifolius*.

In general, it is amazing, how rarely we had difficulties with identification of material as either *L. tenellus* or *L. sessilifolius* subsp. *sessilifolius*, although many specimens have been examined. Indeed, according to herbarium labels, the plants often grow in the same localities and show similar ecological preferences.

Examined specimens: **Canary Islands** (Spain): Tenerife: *Rikli s.n.*, San Juan de la Rambla, 2 Apr. 1908 [Z]; *Murray s.n.*, between Santa Cruz and San Andres, 20 Jun. 1894 [K].

(17) *Lotus sessilifolius* DC., Cat. Pl. Horti Monsp.: 122 (1813). ≡ *Pedrosia sessilifolia* R. Lowe, Man. Fl. Madeira **1**: 177 (1862). ≡ *Lotus glaucus* Ait. subsp. *sessilifolius* (DC.) Bornm., Bot. Jahrb. Syst. **33**: 443 (1903), p.p. ≡ *Lotus glaucus* var. *sessilifolius* (DC.) Pitard, in Pitard & Proust, Iles Canaries: 168 (1908). – Protologue: "Hab. In Tenerifa, unde semina retulit cl. Broussonet."

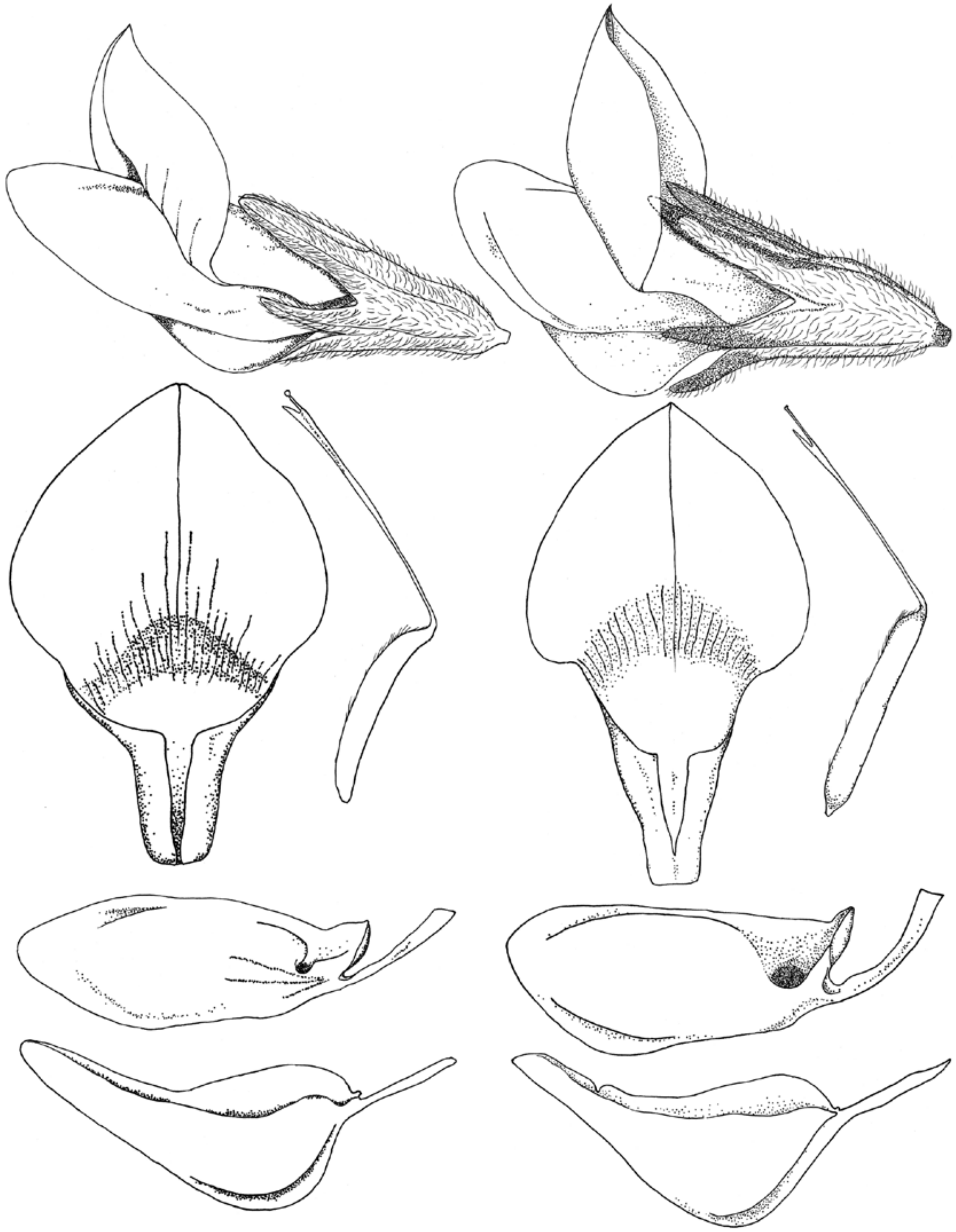

Figure 19: Flower morphology (magnification 5:1). Left, *Lotus sessilifolius* subsp. *sessilifolius* (*Sandral et al. SA-39063*); right, *Lotus sessilifolius* subsp. *villosissimus* (*Sandral et al. SA-40270*).

= *Lotus pentaphyllus* Link, in von Buch, Phys. Beschr. Canar. Ins.: 156 (1825). ≡ *Lotus sessilifolius* DC. var. *pentaphyllus* (Link) D.H. Davis, Studies in the *Lotus glaucus* – *sessilifolius* complex [manuscript] (1971), nom. provis. – Protologue: no exact locality.

(17a) *Lotus sessilifolius* subsp. ***sessilifolius***

Illustrations: figures 7 L–O, 8 K–L, 9 M, 18 A, 19 (left).

Perennial herb or half-shrub with prostrate or ascending shoots. Adventitious roots on shoots absent. Leaves usually shorter than stem internodes, sessile, palmate (rarely with a minute rachis up to 1 mm long), with five leaflets. Stipules not detectable. Leaflets 1.5–9(11) mm long, almost sessile or on petiolules up to 0.4 mm long. Central and lateral leaflets of a leaf of almost the same shape, filiform or linear to oblanceolate or obovate, with maximum width near the middle of a leaflet or above it. Stem and leaf indumentum dense to sparse, with appressed or patent hairs. Indumentum type can vary within an individual, so that most specimens with patent hairs on stems also bear some portions of stems with appressed hairs. Shoots usually with a proximal zone bearing paracladia (or innovation shoots) and a distal zone bearing axillary umbel peduncles. Umbel peduncles straight or incurved, (2)3–16 times longer than their subtending leaves. Sterile bract shorter than calyx, with (0)1–3 leaflets and shortened rachis. Umbels 1–6(8)-flowered. Flower-subtending bracts not detectable or present as very small dark structures. Pedicels 1–3 mm long. Flowers 11–17 mm long. Calyx 6.5–8 mm long, monosymmetric, usually covered by straight patent or curved patent hairs, rarely by straight appressed hairs outside the tube and the teeth; appressed hairs also present inside the teeth. Calyx tube green with purple strips. All teeth attached at the same level (not forming two lips) or the calyx is distinctly two-lipped. Upper teeth shorter than the tube or as long as the tube, rarely slightly exceeding the tube. Lower teeth shorter than the tube and shorter than the upper teeth. Petals glabrous, yellow; standard red-veined inside at the base of its blade. All petals of about the same length or standard slightly longer than other petals. Wings 10–15 mm long, usually 3–3.5 mm wide, not adhering together in their distal parts. Keel 10–15 mm long, tip straight. Stylodium 6–7.5 mm long, tooth always present, glabrous, 0.2–0.8 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, (2)3–5(6) times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): Tenerife: *Aldridge 1616*, Escabonal, 28 Apr. 1973 [RNG]; *Aldridge 1625*, Adeje, Barranco del Infierno, 29 Apr. 1973 [RNG]; *Aldridge 488* and *492*, Punta de Cueva Nueva, S of Barrancos de las Hiedras, near Poris Abona, sea level 27 Jan. 1973 [RNG]; *Andreas 26*, Arico, Feb. 1987 [Z]; *Andreas 27*, Punta Teno, Jan. 1987 [Z]; *Andreas s.n.*, Punta Teno, Jan. 1897 [M]; *Ball s.n.*, Santa Cruz, Apr. 1888 [Z]; *Beck s.n.*, Dünen östlich El Medano, 2 Aug. 1977 [M]; *Bolle s.n.*, Paso Alto [Z]; *Bornmüller 1181*, Guimar, 8 Jun. 1901 [M]; *Bornmüller 2280*, Santa Cruz, 5 June 1901 [LE, Z]; *Bornmüller 2281*, Guimar, alt. 2–300 m, 8 June 1901 [LE, Z]; *Bourgeau 502,* Guimar, Dec. 1845 [LE]; *Bougreau 1324*, Guimar, 24 Feb. 1855 [MA, Z]; *Bramwell 1020*, Punta de Teno, west slopes of Teno Mountains, 250 m, 17 Mar. 1969 [RNG]; *Bramwell 1441*, Punta de Teno, above Teno Bajo, 100 m, 4 May 1969 [RNG]; *Bramwell 1738*, cliffs to S of Punta de Teno, 250 m, 20 Jun. 1969 [RNG]; *Bramwell 2146*, El Escabonal, 400 m, 3 Aug. 1969 [RNG]; *Bramwell 2235*, Ladera de Guimar, 400 m, 1 May 1969 [RNG]; *Bramwell 335*, San Juan de la Rambla, 4 Nov. 1968 [RNG]; *Bramwell 375* and *376*, San Juan de la Rambla, 13 Feb. 1968 [RNG]; *Bramwell 538*, Icod de los Vinos, 150 m, 20 Jan. 1969 [RNG]; *Bramwell 606*, Sierra Anaga, Valle de Bufadero near Santa Cruz, 23 Jan. 1969 [RNG]; *Bramwell 844*, Ladera de Guimar, 500 m, 2 Mar. 1969 [RNG]; *Bramwell 961*, SW coast near Playa de San Juan, 50 m, 9 Mar. 1969 [RNG]; *Bramwell & Humphries 3231*, El Medano, Playa de Confital, 30 m, 3 Apr. 1971 [RNG]; *Bramwell & Humphries 3709*, Barranco de Tamadaya near Arico, 350–500 m, 3 Apr. 1971 [RNG]; *Burchard 203*, Adeje, alt. 200 m, Mar. 1925, [Z]; *Burchard 50*, San Juan de la Rambla, Mar. 1907 [Z]; *Harvey s.n.*, 11 Mar. 1977 [K]; *Hillebrand s.n.*, Guimar, 1882 [Z]; *Hillebrand s.n.*, S. Juan de la Rambla, 7 Apr. 1879 [Z]; *Hintz s.n.*, Candelaria, 13 Jan 1898 [Z]; *Jarvis & Murphy 112*, Poris de Abona near Autopista, 28º9'N, 12º45'W, 20 m, 6 Apr. 1977 [RNG]; *Jarvis 516*, El Medano, dunes to

W of town, 5 m, 1 May 1977 [RNG]; *Lems 203*, San Juan de la Rambla, 3 Aug. 1954 [RNG]; *Lems 6471* and *6472*, Barranco del Infierno, Adeje, 400 m, 9 Dec. 1965 [RNG]; *Malato-Beliz 17631*, W of San Juan de la Rambla, 20 m, 13 Nov. 1968 [MA]; *Pitard 136*, Fasnia, 15 Apr. 1905 [Z]; *Rutishauser & Huber s.n.*, Mirador de Guimar, 8 Oct. 1977 [Z]; *Sandral et al. 04-S7-07-SS*, 28°20.556' N, 16°54.144' W, 23 m, 14 Jul. 2004 (seeds), cultivated in Perth (plot 370) and pressed in 2006 [K, MW]; *Sandral et al. SA-39063, SA-39064, SA-39067* and *SA-39069*, 28°08.455' N, 16°37.137' W, 1244 m, 16 Jul. 2002 (seeds), cultivated in Perth (plots 268, 285, 291 and 352) and pressed in 2006 [K, MW]; *Sandral et al. SA-39080* and *SA-39082*, 28°09.511' N, 16°26.080' W, 30 m, 18 Jul. 2002 (seeds), cultivated in Perth (plots 276 and 383) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39084* and *SA-39087*, 28°22.618' N, 16°42.710' W, 217 m, 18 Jul. 2002 (seeds), cultivated in Perth (plots 234 and 378) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40246*, 28°31.442' N, 16°09.045' W, 71 m, 17 Jul. 2003 (seeds), cultivated in Perth (plot 198) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40289*, 28°11.562' N, 16°28.103' W, 430 m, 25 Jul. 2003 (seeds), cultivated in Perth (plot 384) and pressed in 2005 and 2006 [K, MW]; *Santos et al. 28928*, pedregales al sur del Túnel de Guimar, 20 m, 13 Jan 1983 [ORT]; *Schröter s.n.*, San Juan de la Rambla, 2 Apr. 1908 [Z]; *Schröter s.n.*, San Juan de la Rambla, 12 Apr. 1908 [Z]; *Sventenius s.n.*, Guimar, 23 Mar. 1944 [ORT]; *Valdés-Bermejo s.n.*, Puerto de Guimar, 29 Mar. 1979 [MA]; *Van der Veken 89/478*, Medano, 25 m, 29 Dec. 1989 [M, RNG]; La Gomera: *Simony s.n.*, in Felsritzen nächst dem Roque de los Tableros bei San Sebastian, 80 m, 12 Sept. 1989 [Z].

(17b) ***Lotus sessilifolius*** DC. subsp. ***villosissimus*** (Pitard) Sandral & D.D. Sokoloff, **comb. nova.** ≡ *Lotus glaucus* var. *villosissimus* Pitard, in Pitard & Proust, Iles Canaries: 168 (1908). ≡ *Lotus glaucus* Ait. subsp. *villosissimus* (Pitard) D.H. Davis, Studies in the *Lotus glaucus* – *sessilifolius*-complex [manuscript] (1971), nom. provis. – Lectotype (designated here): *Pitard 135*, El Pozo de Sabinosa, 2 Apr. 1905 [Z-000046111!].

= *Lotus glaucus* Ait. var. *villosus* ("*villosa*") Bornm., Bot. Jahrb. Syst. **33**: 443 (1903), nom. illeg., non *L. glaucus* var. *villosus* Brand (1898). – Holotype: *Bornmüller 2278*, Puerto de Valverde, alt. 100 m, 23 May 1923 [isotype Z!].

Illustrations: figures 7 P–Q, 8 M–N, 9 N, 18 B, 19 (right).

Differs from subsp. *sessilifolius* in patent and often very dense hairs covering all stems and calyces. The hairs are either straight or curved. Leaflets are never filiform or linear. Peduncles usually 1–4-flowered. There is a tendency to have longer calyx teeth than in subsp. *sessilifolius* (upper teeth are always longer than the tube). Standard petal is glabrous or with hairs on the outer surface.

Examined specimens: **Canary Islands** (Spain): Hierro: *Aldridge 1257*, near Valverde, road to Guanaroca, 750 m, 14 Mar. 1973 [RNG]; *Aldridge 1291*, near Restinga, road to S from San Andres, 16 Mar. 1973 [RNG]; *Aldridge 1330*, El Golfo, road from Los Llanillo to Sabinosa, c.500 m, 17 Mar. 1973 [RNG]; *Aldridge 1335*, El Golfo, Pozo de la Salud, near coast to 100 m, 17 Mar. 1973 [RNG]; *Aldridge 1350*, El Golfo, Embarcadero de Punta Grande, coast near Roques y Punta del Salmor, 17 Mar. 1973 [RNG]; *Aldridge 1358*, Las Playas, near Roque de la Bonanza, track from N of Puerto de la Estaca to the sandy beach, 18 Mar. 1973 [RNG]; *Bornmüller 2278*, Puerto de Valverde, 100 m, 23 May 1923 [Z]; *Bramwell 3318*, Cuesta de Sabinosa, 8 Apr. 1971 [RNG] *Burchard 389*, Sabinosa, 50 m, May 1924 [Z]; *Cramer s.n.*, Valverde [Z]; *Fritsch s.n.*, Valverde, June 1863 [Z]; *Jarvis & Murphy 253*, Tamaduste – Valverde road, 3 km S of Tamaduste, 100 m, 11 Apr. 1977 [RNG]; *Lowe s.n.*, El Golfo, between Lu Lupa and Sabinosa, 20 Feb. 1858 [K]; *Murray s.n.*, Pozo de Sabinosa, 11 May 1899 [RNG]; *Pitard 135*, El Pozo de Sabinosa, 2 Apr. 1905 [Z]; *Sandral et al. SA-40264*, 27°48.266' N, 17°58.505' W, 656 m, 19 Jul. 2003, (seeds), cultivated in Perth (plot 259) and pressed in 2005

[MW]; *Sandral et al. SA-40266*, 27°42.152' N, 18°05.151' W, 270 m, 19 Jul. 2003 (seeds), cultivated in Perth (plot 335) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40267*, 27°45.096' N, 18°06.025' W, 73 m, 19 Jul. 2003 (seeds), cultivated in Perth (plot 389) and pressed in 2006 [K, MW]; *Sandral et al. SA-40270*, 27°38.325' N, 17°58.462' W, 22 m, 20 Jul. 2003 (seeds), cultivated in Perth (plot 309) and pressed in 2005 and 2006 [K, MW].

(18) ***Lotus kunkelii*** (Esteve) Bramwell & D.H. Davis, Cuad. Bot. Canaria **16**: 53 (1972). ≡ *Lotus lancerottensis* Webb & Berthel. subsp. *kunkelii* Esteve, Cuad. Bot. Canaria **14–15**: 44 (1972). – Holotype: *Esteve 5424-b*, Barranco de Jinámar, 12 Apr. 1956 [GDA].

Perennial with prostrate shoots. Leaves shorter or longer than stem internodes, sessile, palmate, with five leaflets. Stipules not detectable. Leaflets 1–5 mm long, almost sessile or with petiolules up to 0.3 mm long. Leaflets fleshy, all orbicular to obovate, lateral often wider than central ones, equally sided. Stem and leaves with a very dense indumentum of straight patent hairs. Shoots without a clear differentiation into proximal zone bearing paracladia and a basal zone bearing axillary umbels. Umbel peduncles 5–10 times longer than their subtending leaves. Sterile bract shorter than calyx, with 1–3 leaflets and shortened rachis. Umbels 1–3-flowered. Flower-subtending bracts not detectable or present as dark glands up to 0.2 mm long. Pedicels 1–2 mm long. Calyx 5.5–7 mm long at anthesis and 6.5–8 mm long in fruits, monosymmetric and only slightly two-lipped. Upper calyx teeth longer than the tube, longer and wider than the lower teeth. Lower teeth about as long as the tube. Hairs similar to those on stem and leaves are present on outer surface of the calyx; teeth also with straight hairs inside (sometimes except the lowermost part of a tooth). Petals yellow. Standard (always?) with hairs on the outer surface, other petals glabrous, longer than keel. Wings as long as the keel, 8.5–12 mm long, not adhering together in their distal parts. Keel tip straight. Stylodium 6.5–7.5 mm long, tooth always present, 0.3–0.5 mm long, bearing (always?) some long hairs. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight not constricted or constricted between seeds, 1.5–3 times longer than the calyx.

Examined specimens: **Canary Islands** (Spain): Gran Canaria: *Kunkel 15307*, Jinámar, 29 Dec. 1972 [G]; *Lems 7838*, lower part Barranco Jinámar, 10 m, 2 Jun. 1966 [RNG]; *Sventenius s.n.,* Telde, B^{co} hacia Las Palmas, 19 Mar. 1947 [ORT].

(19) ***Lotus arinagensis*** Bramwell, Bot. Macaronésica **22**: 114 (1995). – Holotype: *Alonso Socorro 10125*, Gran Canaria, Puerto de Arinaga, junto al muelle, 13 Mar. 1974 [LPA].

= *Lotus leptophyllus* auct.: K. Larsen, Biol. Skr. **11**: 21 (1960), non *Pedrosia leptophylla* R. Lowe (1862).

Illustrations: figures 7 R, 8 O, 9 O, 18 C, 19 (left).

Perennial herb with prostrate shoots. Adventitious roots on shoots absent. Leaves usually shorter than stem internodes, sessile, palmate, with five leaflets. Stipules not detectable. Leaflets almost sessile. Leaflets fleshy, 1.5–5 mm long. Lateral leaflets obovate to almost orbicular; central leaflets oblanceolate to obovate or (broadly) elliptic. Stem and leaves with dense indumentum of short appressed hairs, and the general appearance of foliage is whitish. Shoots without clear differentiation into distal zone with lateral umbels and proximal zone with paracladia

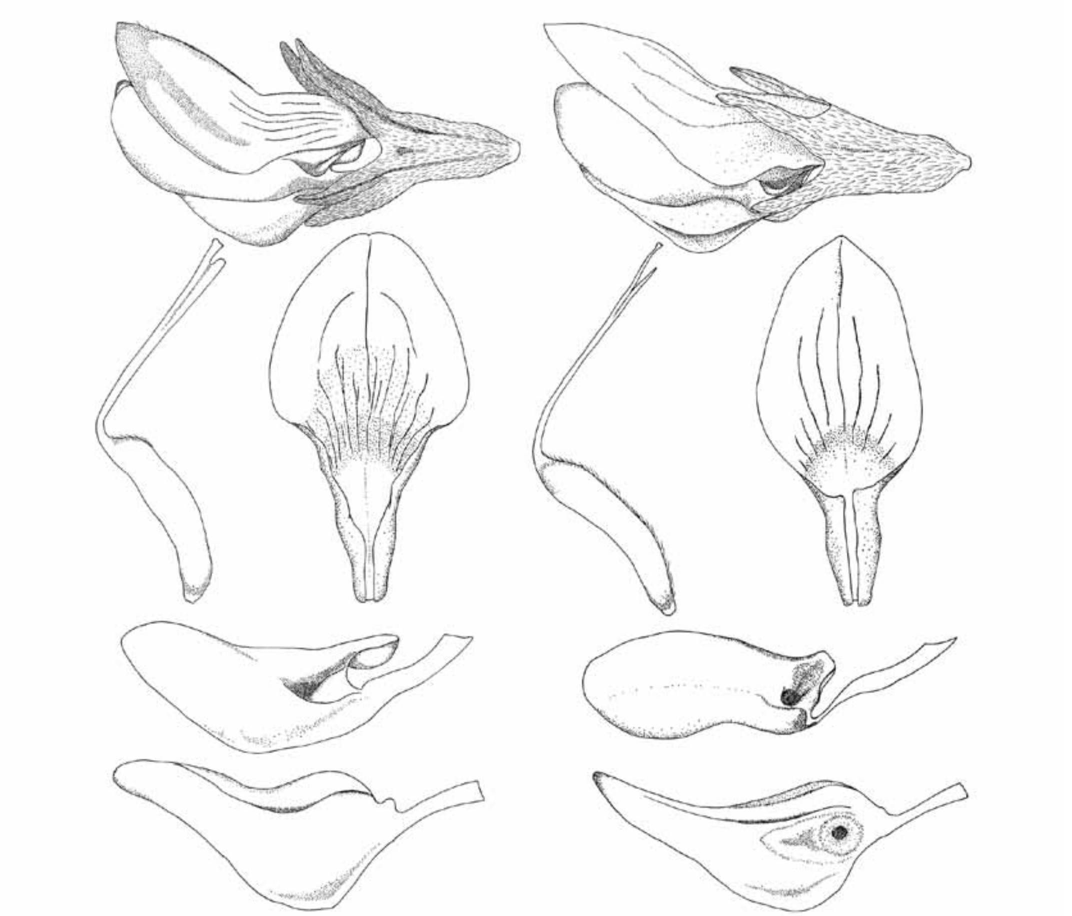

Figure 20: Flower morphology (magnification 5:1). Left, *Lotus arinagensis* (*Sandral et al. SA-40278*); right, *Lotus spartioides* (*Sandral et al. SA-39108*).

(or innovation shots). Umbel peduncles 2–8 times longer than their subtending leaves. Sterile bract shorter than calyx, with 2–3 leaflets and shortened rachis. Umbels 1–6-flowered. Flower-subtending bracts not detectable. Pedicels 1–2 mm long. Flowers 10–11 mm long. Calyx 5–6 mm long at anthesis and up to 6.5 mm in fruits, monosymmetric, covered by straight appressed hairs outside the tube and the teeth as well as inside the teeth; hairs less dense on the tube than on the teeth. All teeth attached at the same level (not forming two lips), but two upper ones are reflexed upwards and three lower ones are reflexed downwards. Calyx tube green with purple strips. All calyx teeth usually shorter than the tube, upper teeth slightly longer that lower ones. Two upper teeth slightly wider than three lower ones. Pre-anthetic and anthetic petals yellow; standard red-veined inside at the base of its blade and with wide red strips (that are often more prominent on either left or right side) outside. Post-anthetic petals brownish or reddish. Standard glabrous or with few hairs outside in distal part; other petals glabrous. Standard almost as long as the keel. Wings 9–9.5 mm long, slightly shorter than the keel, around 3 mm wide, not adhering together in their distal parts. Keel 9.5–10 mm long, tip straight. Stylodium 5.5–6 mm long, tooth always present, glabrous, 0.2 mm long. Ovary and fruit with hairs along the distal part of ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 1.5–5.5 times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): Gran Canaria: *Bramwell 1205a*, Punta de Arinaga, 10 m, 30 Mar. 1969 [RNG]; *Bramwell 1205b*, Punta de Arinaga, 10 m, 1 Apr. 1969 [RNG]; *Bramwell & Humphries 3096*, Punta de Arinaga, 20 m, 23 Mar. 1971 [RNG]; *Kunkel 12303* Punta de Arinaga, 17 Jan. 1969 [M]; *Sandral et al. SA-40278*, 27°51.389' N, 15°23.160' W, 29 m, 22 Jul. 2003 (seeds), cultivated in Perth (plot 232) and pressed in 2005 and 2006 [K, MW].

(20) ***Lotus mascaënsis*** Burchard, Repert. Spec. Nov. Regni Veg. **7**: 328 (1909). – Lectotype (designated here): *Burchard s.n.*, Valle de Masca, 700 m, Apr. 1909 [K!].

Small shrub or half-shrub with erect or prostrate shoots. Leaves shorter or longer than stem internodes, sessile, pinnate or palmate, with five leaflets. Stipules not detectable. Leaflets with very short hairy petiolules. Leaf rachis, if present, up to 3 mm long, much shorter than basal leaflets. All leaflets linear, 5–18 mm long. Stem and leaf indumentum of dense straight appressed or semi-patent hairs. Stem surface is not visible between hairs. Shoots (always?) with a proximal zone comprising nodes with paracladia or innovation shoots and a distal zone comprising nodes with axillary umbels. Additional buds in serial axillary complexes give rise paracladia or innovation shoots. Umbel peduncles 1–4 times longer than their subtending leaves. Sterile bract shorter than the calyx, with shortened rachis and (1–)3 leaflets. Umbels 1–4-flowered. Flower-subtending bracts not detectable or present as small dark glands. Pedicels 1–2 mm long. Calyx (8)9–12(13) mm long, slightly monosymmetric; teeth longer than the tube; upper teeth longer and wider than lower teeth. Calyx tube and teeth with straight patent hairs outside, teeth also with appressed hairs inside. Petals yellow. All petals glabrous or standard with abundant hairs on the outer surface. Standard longer than the keel. Wings 11–16 mm long, as long as or shorter than the keel, around 3 mm wide, not adhering together in their distal parts. Keel 12–16 mm long, tip straight. Stylodium 7–8 mm long, tooth always present, glabrous, 0.3–0.5 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 2–4 times longer than the calyx.

Examined specimens: **Canary Islands** (Spain): Tenerife: *Acebes et al. 6669*, talud lateral de la pista de Masca, 1 May 1976 [MA]; *Bramwell 1399,* Valle de Masca, on dry slopes above the village of Masca, 600 m, 25 Apr. 1969 [MA, RNG]; *Bramwell 3468*, Barranco de Masca, 500 m, 19 Apr. 1971 [RNG]; *Burchard 316*, supra oppidum Masca, Apr. 1909 [K, M, W]; *Burchard s.n.,* in convalle de Masca dicto, Apr. 1909 [ORT]; *Burchard s.n.*, Valle de Masca, 700 m, Apr. 1909 [K]; *Burchard s.n.*, 700–750 m, Mar. 1909 [Z]; *Lems 7380*, trail to Masca, 800–1000 m, 4 Apr. 1966 [RNG]; *Malato Beliz 14073*, Masca, 650 m, 7 May 1946 [MA].

(21) ***Lotus spartioides*** Webb & Berthel., Phyt. Canar. **2**: 81 (1842), tab. 64 (1843). ≡ *Lotus campylocladus* Webb & Berthel. var. *spartioides* (Webb & Berthel.) Brand, Bot. Jahrb. Syst. **25**: 201 (1898), p.p. ≡ *Lotus glaucus* Ait. subsp. *spartioides* (Webb & Berthel.) Bornm., Bot. Jahrb. Syst. **33**: 443 (1903). – Protologue: "In altis montibus Canariae, ubi rupibus abruptis qui veluti parietes vorticem ingentem la caldera de Tiraxana circumclaudunt anno 1839 maio mense florentem primus invenit cl. Despréaux". Original material: "*Lotus spartioides* Nob. in rupibus alti Tiraxanae Canariae, Despréaux", May 1839, № 19 [FI – Herb. Webb. 044781, image seen].

= *Lotus holosericus* Webb & Berthel., Phyt. Canar. **2**: 83 (1842), tab. 63 (1843). – Protologue: "In Canariae montibus prope Mogan, ubi paucos tantum pedes vidit cl. Despréaux". Original

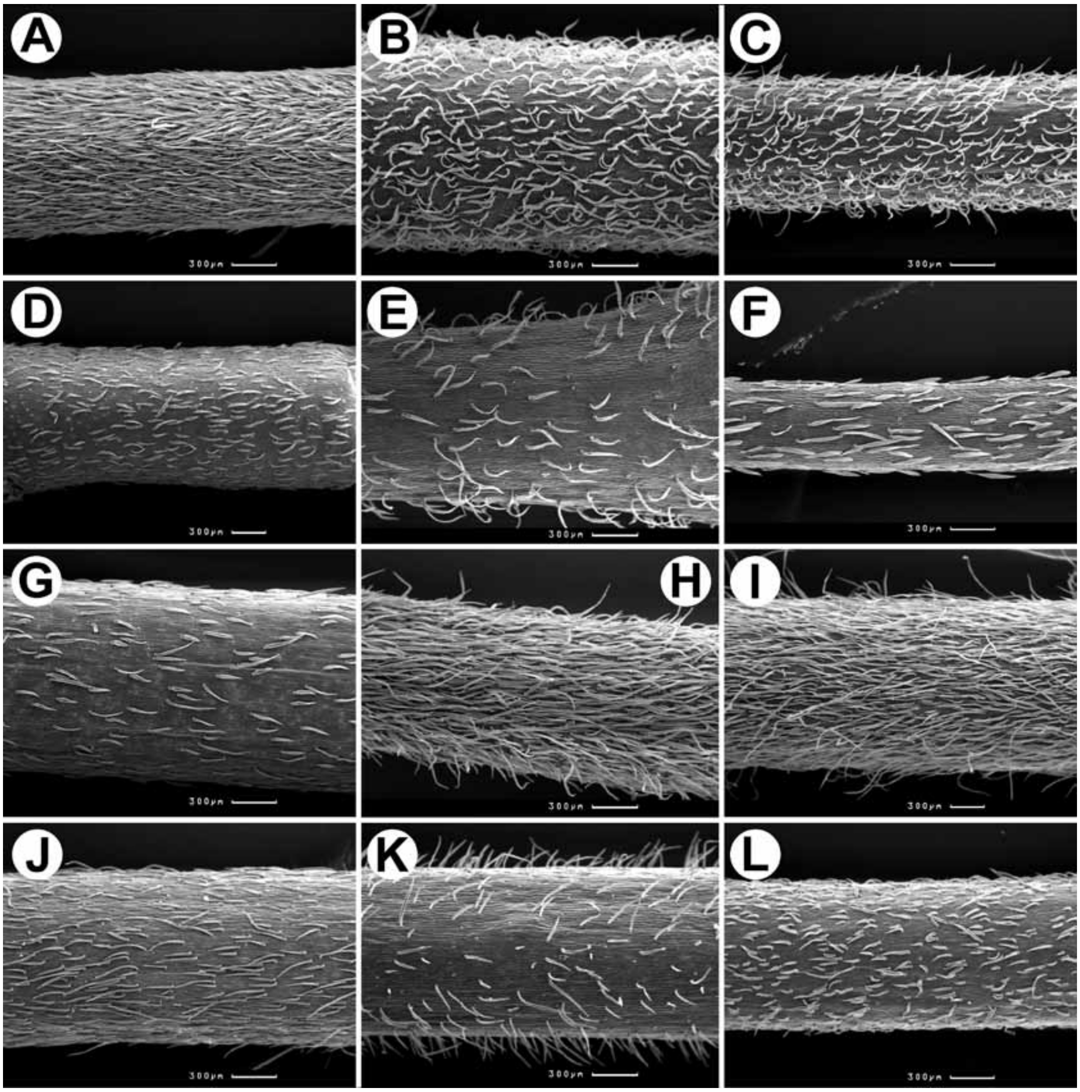

Figure 21: Details of stem indumentum (SEM). All scale bars = 300 µm. A, *Lotus spartioides* (*Sandral et al. SA-39111*); B, *Lotus campylocladus* subsp. *campylocladus* (*Sandral et al. SA-39055*); C, *Lotus campylocladus* subsp. *hillebrandii* (*Sandral et al. SA-40330*); D, *Lotus emeroides* (*Sandral et al. 03-S51-146-SR*); E, *Lotus callis-viridis* (*Sandral et al. 04-S10-10-SS*); F, *Lotus purpureus* (*SA-39011*); G, *Lotus brunneri* (*Sandral et al. SA-40297*); H–I, *Lotus latifolius* (H, *Sandral et al. 03-S81-250-S*; I, *Sandral et al. 03-S77-238-S*); J–K, *Lotus jacobaeus* (J, *Sandral et al. SA-40293*; K, *Sandral et al. SA-40294*); L, *Lotus arborescens* (*Sandral et al. SA-40348*).

material: " № 11. Lotus holosericeus Nob. <...> Mogan, May 1839" [FI – Herb. Webb. 044664, image seen].

Illustrations: figures 18 D, 20 (right), 21 A, 22 A, 23 A–B.

Small shrub with erect shoots (shoots are more or less ascending in first year of growth, then erect shoots develop). Adventitious roots on shoots absent. Leaves usually shorter than stem internodes, sessile or with short petioles up to 0.4 mm long, pinnate, with five leaflets. Stipules not detectable. Leaflets with petiolules up to 0.4 mm long. Leaf rachis flattened, 0.5–1 mm wide, 0.5–6 mm long, shorter than or as long as basal leaflets. Basal leaflets 2–10(11) mm long, lanceolate or oblanceolate to linear, equally sided. All three distal leaflets attached to the top of the rachis. They are as long as or longer than basal leaflets, 2–11(12) mm long, oblanceolate to linear. Quite rarely the leaflets are obovate, and then the leaves are very small. Stem and leaf indumentum of straight appressed or straight (slightly curved) patent (semi-patent) hairs. Stem and leaf surface visible or not visible between hairs. Shoots usually with a proximal zone comprising nodes with paracladia or innovation shoots and a distal zone comprising nodes with axillary umbels. Sometimes the branching pattern is more complex, and one or few nodes with paracladia or innovation shoots are inserted between nodes with axillary umbels. Additional buds give rise paracladia or innovation shoots or rarely (in the distal part of the shoots) additional umbels. Umbel peduncles 1.5–5 times longer than their subtending leaves. Sterile bract much shorter than the calyx (rarely as long as or longer than the calyx), with shortened rachis and one to three leaflets. Umbels 1–10-flowered. Flower-subtending bracts usually absent. Pedicels 0.5–1 mm long. Calyx 6–9 mm long, monosymmetric, slightly two-lipped. Calyx teeth shorter than the tube (or upper teeth as long as the tube); upper teeth longer and wider than lower teeth. Calyx tube and teeth with straight or slightly curved appressed or patent hairs outside; teeth margin with straight hairs; upper teeth with appressed hairs inside in their distal part; lower teeth inside entirely glabrous or with appressed hairs in their distal part only. Anthetic petals yellow; standard blade with brown strips inside. All petals glabrous. Standard longer than the keel. Wings 8–16 mm long, as long as or slightly longer than the keel, 2.5–4 mm wide, not adhering or adhering together in their distal parts. Keel 8–15 mm long, tip straight. Stylodium 5–6.5 mm long, tooth always present, glabrous, 0.3–0.5 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 2–4 times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): <u>Gran Canaria</u>: *Austin M4*, Tamadaba Mt. near Aqaete, 1350 m, 25 Jul. 1960 [K]; *Bornmüller 540*, Caldera da Bandama, 400–500 m, 17 May, 1900 [Z]; *Bourgeau 379*, la Calderita de la Cumbre, Apr. 1846 [K]; *Burchard 14*, Caldera de Tirajana, 800 m, 20 May [Z]; *Burchard 249*, la Caldera de Tiraxana, 1000 m, May 1908 [M, Z]; *Kunkel 10697*, Tamadaba – Tirma, 1100 m, 17 Mar. 1967 [M]; *Kunkel 11064*, Tamadaba, 1200 m, 10 May 1967 [G]; *Kunkel 12672*, Pinar de Pajonales, 1000 m, 16 Mar. 1969 [M]; *Kunkel 15929*, Barranco de Ayagaures, 200 m, 20 Oct.1973 [G]; *Kunkel 19156*, Degollada de la Benzanilla, 1000 m, 15 Apr. 1976 [G]; *Lems 2979*, Caldera de Bandama, 350 m, 14 Aug. 1956 [RNG]; *Sandral et al. 04-S11-11-SS*, 28°01.675' N, 15°40.456' W, 1103 m, 15 Jul. 2004 (seeds), cultivated in Perth (plot 197) and pressed in 2005 [MW]; *Sandral et al. 04-S12-12-SS*, 27°57.131' N, 15°37.900' W, 1170 m, 15 Jul. 2004 (seeds), cultivated in Perth (plot 316) and pressed in 2005 [MW], cultivated in Adelaide from seeds collected in Perth (as *SA-43893*) and pressed in 2006 [K, MW]; *Sandral et al. 04-S13-13-SS*, 27°56.933' N, 15°34.532' W, 1247 m, 15 Jul. 2004 (seeds), cultivated in Perth (plot 386) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39024* and *SA-39026*, 27°56.982' N, 15°37.947' W, 753 m, 10 Jul. 2002 (seeds), cultivated in Perth (plots 244 and 281) and pressed in 2006 [K, MW]; *Sandral et al. SA-39097* and *SA-39099*, 28°03.859' N, 15°27.522' W, 328 m, 20 Jul. 2002 (seeds), cultivated in Perth (plots 231 and 258) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39100*, 28°01.671' N, 15°27.405' W, 1115 m, 20 Jul. 2002 (seeds), cultivated in Perth (plot 246) and pressed in 2005 [MW]; *Sandral et al. SA-39103, SA-39104, SA-39108* and *SA-39111*, 28°01.007' N, 15°26.311' W, 720 m, 20 Jul. 2002 (seeds), cultivated in Perth (plots 204, 217, 239 and 262) and pressed in 2006 [K, MW]; *Sandral et al. SA-40276* and *SA-40277*, 27°54.554' N, 15°34.298' W, 948 m, 22 Jul. 2003 (seeds), cultivated in Perth (plots 314 and

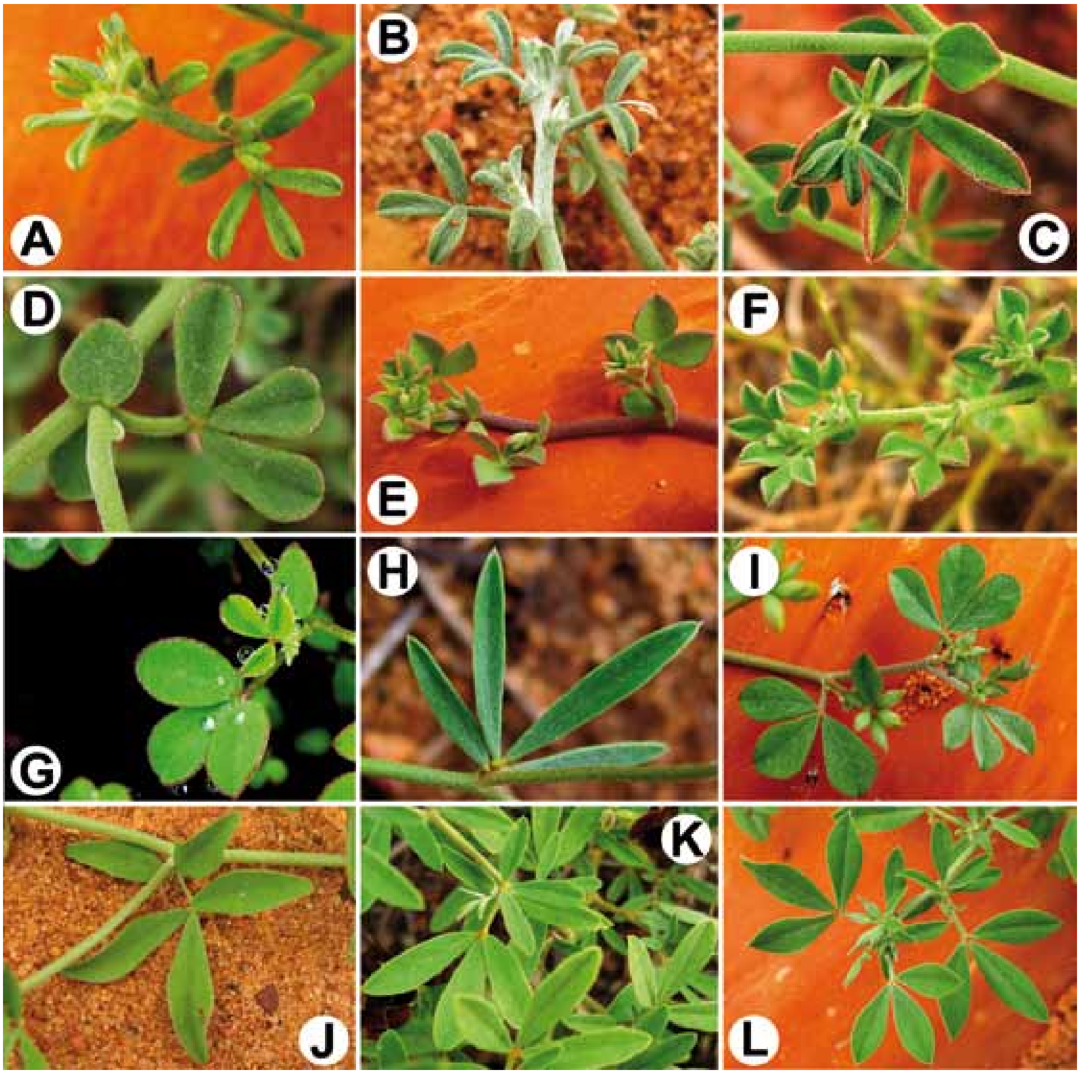

Figure 22: Photos showing leaf morphology. A, *Lotus spartioides* (*Sandral et al. SA-39108*); B, *Lotus campylocladus* subsp. *campylocladus* (*Sandral et al. SA-39066*); C–D, *Lotus campylocladus* subsp. *hillebrandii* (C, *Sandral et al. 04-S21-21-S*; D, *Sandral et al. SA-40325*); E, *Lotus emeroides* (*Sandral et al. 03-S51-146-SR*); F, *Lotus callis-viridis* (*Sandral et al. SA-40279*); G, *Lotus purpureus* (*SA-39011*); H–I, *Lotus brunneri* (H, *Sandral et al. SA-40291*; I, *Sandral et al. SA-40297*); J, *Lotus latifolius* (*Sandral et al. SA-40345*); K, *Lotus jacobaeus* (*Sandral et al. SA-40293*); L, *Lotus arborescens* (*Sandral et al. SA-40352*).

238) and pressed in 2005 [MW]; *Sandral et al. SA-40310*, 27°55.805' N, 15°38.874' W, 1263 m, 20 Jul. 2003 (seeds), cultivated in Perth (plot 226) and pressed in 2005 [MW]; *Sandral et al. SA-40312*, 28°01.675' N, 15°40.435' W, 1115 m, 20 Jul. 2003 (seeds), cultivated in Perth (plot 278) and pressed in 2006 [K, MW]; *Santos s.n.,* San Bartolomé de Tirajana, 9 Jun. 1972 [ORT]; *Sventenius 2290*, Cumbre de Tirma, 25 May 1948 [ORT]; *Vašák s.n.*, prope Ayacata, Barranco de Soria, 800 m, 10 Feb. 1993 [W].

(22) ***Lotus campylocladus*** Webb & Berthel., Phyt. Canar. **2**: 83 (1842), tab. 62 (1837). – Protologue: Tenerife, "post oppidulum Guimar ad altitudinem sylvarum, id est ad altitudinem 200 circiter pedum super Oceanum". Original material: *Webb s.n.,* "*Lotus campylocladus* Nob. Hab. in petrosis montium vallis Guimariensis" [P!], "*Lotus campylocladus* Nob. 44 <...> in montibus Teneriffa ad marginem regionis sylvosa" [FI – Herb. Webb. 044445, image seen].

(22a) *Lotus campylocladus* Webb & Berthel. subsp. *campylocladus*

Illustrations: figures 18 E, 21 B, 22 B, 23 C, 24 (left).

Half-shrub or a dwarf shrub with prostrate, ascending and erect shoots. Adventitious roots on shoots absent. Leaves usually shorter (often much shorter) than stem internodes, sessile or with short petioles up to 0.6 mm long, pinnate, with five leaflets. Stipules not detectable. Leaflets with petiolules 0.1–0.6 mm long. Leaf rachis considerably flattened, 0.6–0.9 mm wide, (0.5)1–6(7) mm long, slightly shorter to longer than basal leaflets (rarely much shorter than basal leaflets). Basal leaflets 0.5–8(9) mm long, (narrowly) lanceolate or oblanceolate, elliptic, ovate, or obovate, usually equally sided. All three distal leaflets attached to the top of the rachis. They are usually longer than basal leaflets, 1–9(10) mm long, with maximum width in the upper or middle part of a leaflet, oblanceolate, narrowly elliptic to elliptic (rarely wider), usually obtuse, but sometimes emarginate. Stem and leaf indumentum of short curved, usually appressed hairs; rarely hairs are long and patent. Stem and leaf surface visible between hairs. Shoots with a proximal zone bearing branches repeating structure of main shoot, then with a zone bearing axillary umbels, and then often again with a zone bearing branches repeating structure of main shoot; additional axillary buds give rise numerous repeating shoots. More complex branching patterns also present. Umbel peduncles 2–10 times longer than their subtending leaves. Sterile bract much shorter than the calyx, with shortened rachis and one to three leaflets, sometimes without leaflets (as a scale). Umbels (1–)3–6-flowered. Flower-subtending bracts usually absent. Pedicels 0.5–1.5 mm long. Calyx 6–9 mm long, monosymmetric, only slightly or not two-lipped. Upper teeth longer than the tube, longer and wider than lower teeth. Lower teeth about as long as the tube. Calyx tube and teeth with more or less curved hairs outside; teeth margin with straight hairs; upper teeth with appressed hairs inside in their distal part; lower teeth inside entirely glabrous or with appressed hairs in their distal part only. Anthetic petals yellow; standard blade with brown strips inside. Postanthetic petals may be brownish. All petals glabrous. Standard longer than the keel. Wings 10–13 mm long, slightly longer than the keel, 2.5–4.5 mm wide, not adhering together in their distal parts. Keel 9.5–12.5 mm long, tip straight. Stylodium 6.5–7.5 mm long, tooth always present, glabrous, 0.1–0.6 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, (2)3–5 times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): Tenerife: *Beck s.n.*, von El Topo nach Augamansa, 3 Aug. 1977 [M]; *Bellot & Ron s.n.*, Las Cañadas, 13 Apr. 1968 [MA]; *Bornmüller 2283*, Taganana, 3–400 m, 30 May 1901 [Z-00035017]; *Bramwell 1019*, Montañas de Teno, Punta de Teno, in cinder on Faro promontory, 5 m, 17 Mar. 1969 [RNG]; *Breitfeld s.n.*, Cañadas, 2200 m [M]; *Burchard 136*, 'el filio de las Cañadas', Jun. 1906 [M]; *Burchard 251,* Taganana, Feb. 1909 [Z]; *Castroviejo 9728SC,* La Fortaleza, 1 Dec. 1985 [MA]; *Guerola Soler s.n.*, Cañadas del Teide, 1000 m, 1 May 1992 [MA]; *Jarvis 669*, 15 km E of Chio, near Montana Guirre, 1600 m, 12 May 1977 [RNG]; *Lewis 2180*, 6 km S of Villaflor, 14 Mar. 1995 [K]; *Pérez de Paz s.n.,* La Fortaleza, 19 May 1973 [MA]; *Rivas Goday s.n.*, Villaflor, 9 Apr. 1952 [MA]; *Sandral et al. SA-39055* and *SA-39059*, 28°19.812' N, 16°46.334' W, 1102 m, 15 Jul. 2002 (seeds), cultivated in Perth (plots 238 and 325) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39059*, 28°19.812' N, 16°46.334' W, 1102 m, 15 Jul.

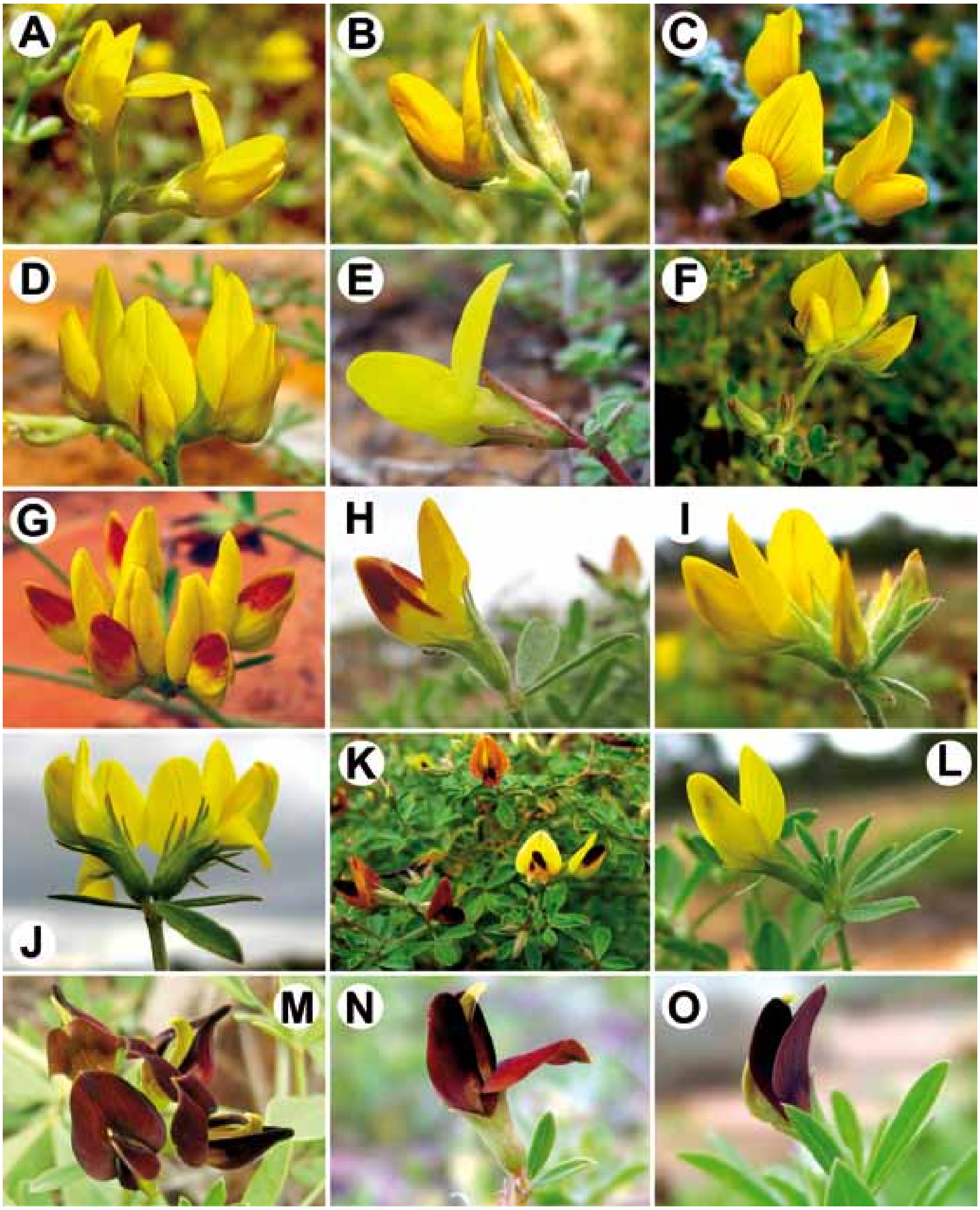

Figure 23: Photos showing flower morphology. A–B, *Lotus spartioides* (A, *Sandral et al. SA-39108*; B, *Sandral et al. 04-S12-12-SS*); C, *Lotus campylocladus* subsp. *campylocladus* (*Sandral et al. SA-39055*); D, *Lotus campylocladus* subsp. *hillebrandii* (*Sandral et al. 04-S21-21-S*); E, *Lotus emeroides* (*Sandral et al. 04-S17-17-SS*); F, *Lotus callis-viridis* (*Sandral et al. SA-40279*); G–I, *Lotus latifolius* (G, *Sandral et al. SA-40345*; H–I, *Sandral et al. 03-S77-238-S*); J, *Lotus brunneri* (*Sandral et al. SA-40291*); K–L, *Lotus arborescens* (K, *Sandral et al. SA-40352*; L, *Sandral et al. SA-40348*); M–O, *Lotus jacobaeus* (all images taken from *Sandral et al. SA-40293*).

2002 (seeds), cultivated in Perth (plot 325) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-39070* and *SA-39071*, 28°08.455' N, 16°37.137' W, 1244 m, 16 Jul. 2002 (seeds), cultivated in Perth (plots 343 and 353) and pressed in 2006 [K, MW]; *Sandral et al. SA-40284*, 28°14.514' N, 16°45.546' W, 1237 m, 25 Jul. 2003 (seeds), cultivated in Perth (plot 242) and pressed in 2005 [MW]; *Sandral et al. SA-40285*, 28°10.205' N, 16°38.480' W, 1814 m, 25 Jul. 2003 (seeds), cultivated in Perth (plot 304) and pressed in 2005 [MW]; *Sandral et al. SA-40287*, 28°07.434' N, 16°35.481' W, 853 m, 25 Jul. 2003 (seeds), cultivated in Perth (plot 377) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40336*, 28°16.138' N, 16°44.917' W, 1607 m, 25 Jul. 2003 (seeds), cultivated in Perth (plot 294) and pressed in 2005 [MW]; *Sventenius s.n.,* Fortaleza, 23 Apr. 1944 [ORT]; *Urschler s.n.*, Las Cañadas, Jul. 1968 [M].

(22b) ***Lotus campylocladus*** Webb & Berthel. subsp. ***hillebrandii*** (Christ) Scott [in sched, herb. K] ex Sandral & D.D. Sokoloff, **comb. nova.** ≡ *Lotus hillebrandii* Christ, Bot. Jahrb. Syst. **9**: 122 (1887). ≡ *Lotus campylocladus* Webb & Berthel. var. *hillebrandii* (Christ) Bornm., Bot. Jahrb. Syst. **33**: 443 (1903); Pitard, in Pitard & Proust, Iles Canaries: 167 (1908).– Lectotype (designated here): *Hillebrand s.n.*, Barr[anco] de Angustias, Apr. 1880 [Z!].

= *Lotus campylocladus* Webb & Berthel. var. *spartioides* (Webb & Berthel.) Brand, Bot. Jahrb. Syst. **25**: 201 (1898), p.p., non *Lotus spartioides* Webb & Berth.

= *Lotus arenarius* auct. non Brot.: R.P. Murray, J. Bot. **35**: 383 (1897).

Illustrations: figures 18 F, 21 C, 22 C–D, 23 D, 24 (right).

The following details of the description are not the same as in subsp. *campylocladus*. Leaf rachis flattened, 0.6–1 mm wide, 2–13 mm long, slightly shorter to slightly longer than basal leaflets. Basal leaflets 2–14 mm long, with maximum width in the lower, middle or upper part of a leaflet, ovate, elliptic, or obovate (rarely almost orbicular, lanceolate or oblanceolate), equally or slightly unequally sided. Distal leaflets 3–25 mm long, with maximum width in the upper part of a leaflet, obovate or oblanceolate. Stem and leaf indumentum of straight or curved, appressed or patent hairs.

Selected examined specimens: **Canary Islands** (Spain): La Palma: *Aldridge 1421*, near Los Quemados, S of Fuencaliente, 27 Mar. 1973 [RNG]; *Aldridge 1469*, track to La Cumbrecita, 900–1200 m, 30 Mar. 1973 [RNG]; *Beck s.n.,* La Cumbrecita, 4 Aug. 1977 [M]; *Bramwell & Humphries 3421*, below Fuencaliente, 200 m, 15 Apr. 1971 [RNG]; *Bramwell 1852*, Fuencaliente, near Volcano de San Antonio, 350 m, 8 Jun. 1969 [RNG]; *Bramwell 1856*, Pinar de Fuencaliente, 850 m, 9 Jun. 1969 [RNG]; *Bramwell 1893*, Barranco de las Angustias, 500 m, 10 Jun. 1969 [RNG]; *Bramwell 1917*, Tijarafe, Barranco de la Candalaria, 900 m, 12 Jun. 1969 [RNG]; *Bramwell 3556*, La Cumbrecita, 1600 m, 29 Jul. 1972 [RNG]; *Breitfeld s.n.*, 1968 [M]; *Burchard 250*, in cratere ingenti 'la Gran Caldera' dicto, 1200 m, May 1907 [M, Z]; *Ceballos & Ortuño 65712*, Barranco de Jacagua, 26 Jul. 1946 [MA]; *Fernández Casas 3034*, inter Santa Cruz de la Palma et Pico de la Santa Cruz, 1400 m, 6 Apr. 1980 [M, MA, RNG]; *Hillebrand s.n.*, Barr[anco] de Angustias, Apr. 1880 [Z]; *Kunkel 12955*, Fuencaliente, 200 m, 27 Dec. 1969 [G]; *Lems 5796*, Jedey, 1 Sep. 1965 [RNG]; *Lems 7710*, Barranco de las Angustias, along the canal from Lomo del Caballo to Taburiente, 480 m, 20 May 1966 [RNG]; *Maas & Maas 8857,* 5 km N of Faro de Fuencaliente on road to Santa Cruz, 22 Feb. 2000 [K]; *Murray s.n.*, Combrecita, 15 Jun. 1892 [K, RNG]; *Nydegger 25327*, zwischen Tiguerorte und Fuencaliente,

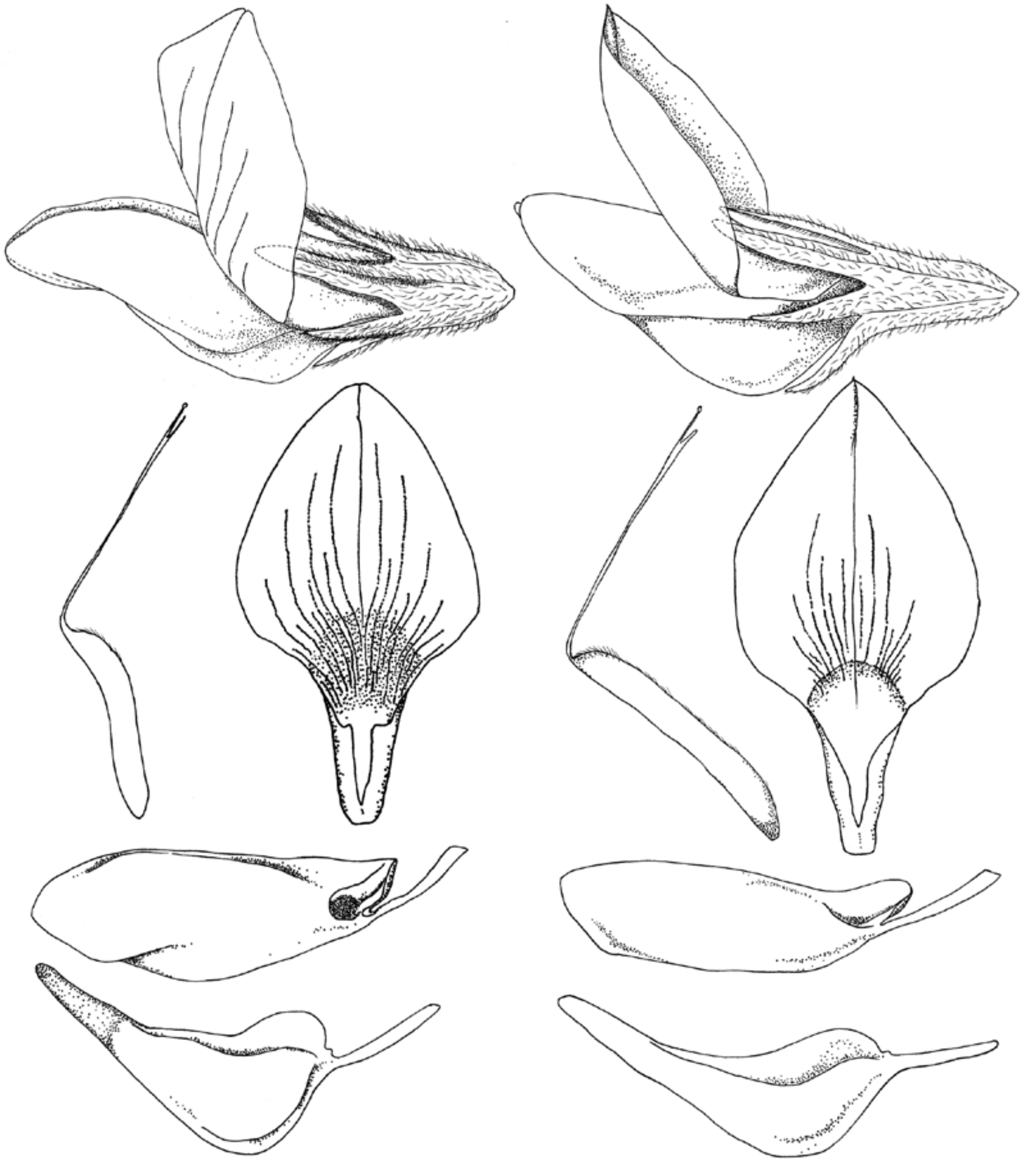

Figure 24: Flower morphology (magnification 5:1). Left, *Lotus campylocladus* subsp. *campylocladus* (*Sandral et al. SA-39055*); right, *Lotus campylocladus* subsp. *hillebrandii* (*Sandral et al. 04-S21-21-S*).

630 m, 9 Feb. 1988 [M, MA, RNG]; *Sandral et al. 04-S21-21-S*, 28°46.916' N, 17°56.947' W, 1025 m, 18 Jul. 2004 (seeds), cultivated in Perth (plot 237) and pressed in 2006 [MW]; *Sandral et al. SA-40325*, 28°32.813' N, 17°47.646' W, 403 m, 23 Jul. 2003 (seeds), cultivated in Perth (plot 248) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40326*, 28°29.705' N, 17°50.324' W, 702 m, 23 Jul. 2003 (seeds), cultivated in Perth (plot 272) and pressed in 2005 [MW]; *Sandral et al. SA-40330*, 28°30.371' N, 17°51.220' W, 751 m, 23 Jul. 2003 (seeds), cultivated in Perth (plot 199) and pressed in 2005 [MW]; *Sandral et al. SA-40335*, 28°43.795' N, 17°48.980' W, 1768 m, 24 Jul. 2003 (seeds), cultivated in Perth (plot 312) and pressed in 2005 [MW]; *Santos 4835*, Lomo de las Chozas, Jul. 1977 [MA]; *Wittmann & Weber 15699*, south rim of Caldera de Taburiente, 28 Mar. 1980 [AD].

(23) *Lotus emeroides* Webb ex R.P. Murray, J. Bot. **35**: 384 (1897). – Lectotype (designated here): *Murray s.n.,* Hermigua, 25 May 1894 [K!].

= *Lotus borzii* Pitard, in Pitard & Proust, Iles Canaries: 167 (1908). – Protologue: "Gomera: Cumbre del Carbonero (600 à 800 m), versant occidental, près d'Hermigua (300 m), d'Agulo au Roquillo (300 m), Barranco de la Laya (700 m)", "Pl. Canarienses N 137 et 537".

Illustrations: figures 18 G, 21 D, 22 E, 23 E, 25 (left).

Perennial herb typically with much branching prostrate shoots; innovation shoots may develop at distal parts of long prostrate shoots of the previous year, giving rise to mat-forming plants, however, no adventitious roots are formed. Leaves shorter or longer than internodes, sessile, with five leaflets. Stipules not detectable. Leaflets on petiolules 0.5–0.6 mm long. Leaf rachis slightly flattened, 0.6–0.8 mm wide, 2–9 mm long, about as long as or longer than basal leaflets. Basal leaflets 1–7 mm long, with maximum width in the middle of the leaflet, slightly below or slightly above it, orbicular, elliptic, broadly ovate or broadly obovate, typically equally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 2–13 mm long, with maximum width in the upper or middle part of a leaflet, triangular, orbicular, or obovate. Stem and leaves with short (0.1–0.2 mm long) almost straight appressed hairs; or the indumentum is of patent hairs. Stem and leaf indumentum not dense, with organ surface visible between hairs. Indumentum densities on adaxial and abaxial leaflet surfaces are alike. Shoots with a proximal portion (often 6 to 12 nodes) bearing axillary shoots more or less repeating architecture of main shoot, then a portion bearing axillary umbels (typically this zone is not long, one to six nodes), and then often again a zone with axillary repeating shoots; the growth of this distal zone may continue growth during the next season making shoot innovation monopodial. Additional axillary buds give rise repeating shoots. They may develop during next growth season (thus being innovation shoots). Umbel peduncles typically 2–5 times longer than their subtending leaves. Sterile bract shorter than the calyx, with (2)3(4) often unequal leaflets and shortened rachis. Umbels 1–5-flowered. Flower-subtending bracts usually not detectable, rarely present as small dark glands. Pedicels 2–3 mm long. Calyx 7.5–9 mm long, monosymmetric and two-lipped. Lower calyx lip slightly shorter to 1.5 times longer than the tube; upper calyx lip as long as or considerably longer than the tube and slightly longer than the lower lip. Two upper teeth wider than three lower ones. Corolla yellow or more often yellow with red or reddish areas on some petals. All petals glabrous. Standard usually longer than the keel. Wings 12–15 mm long, longer than or as long as the keel, 3.5–4.5 mm wide, not adhering together in their distal parts. Keel 11–13 mm long, tip straight. Stylodium 5–6.5 mm long, tooth always present, glabrous, up to 0.3 mm long. Ovary and fruit with very few hairs along the ventral suture, otherwise glabrous, sometimes fruits and ovaries entirely glabrous. Fruit straight, not or slightly constricted between seeds, 2–4 times longer than the calyx.

Selected examined specimens: **Canary Islands** (Spain): La Gomera: *Aldridge 1035*, Puerto de Vallehermoso, sea level, 6 Mar. 1973 [RNG]; *Aldridge 1113*, road from Vallehermoso to Hermigua, just before Tamargada, ca. 450 m, 9 Mar. 1973 [RNG]; *Aldridge 1128*, road from Vallehermoso to Hermigua, just before Tamargada, ca. 450 m, 9 Mar. 1973 [RNG]; *Bramwell 1935,* Barranco de La Villa, 600 m, 25 Jun. 1969 [MA, RNG]; *Bramwell 2072*, Lomo de Carreton, 800 m, 7 Jul. 1969 [RNG]; *Bramwell 453*, below Roque Cano de Vallehermoso, 350 m, 13 Dec. 1968 [RNG]; *Breitfeld s.n.,* Valle Hermoso, 1971 [M]; *Burchard 963,* prope et supra Hermigua, 300–500 m, 13 May 1914 [K]; *Jarvis 560*, near Agule, 40 m, 7 May 1977 [RNG]; *Kunkel*

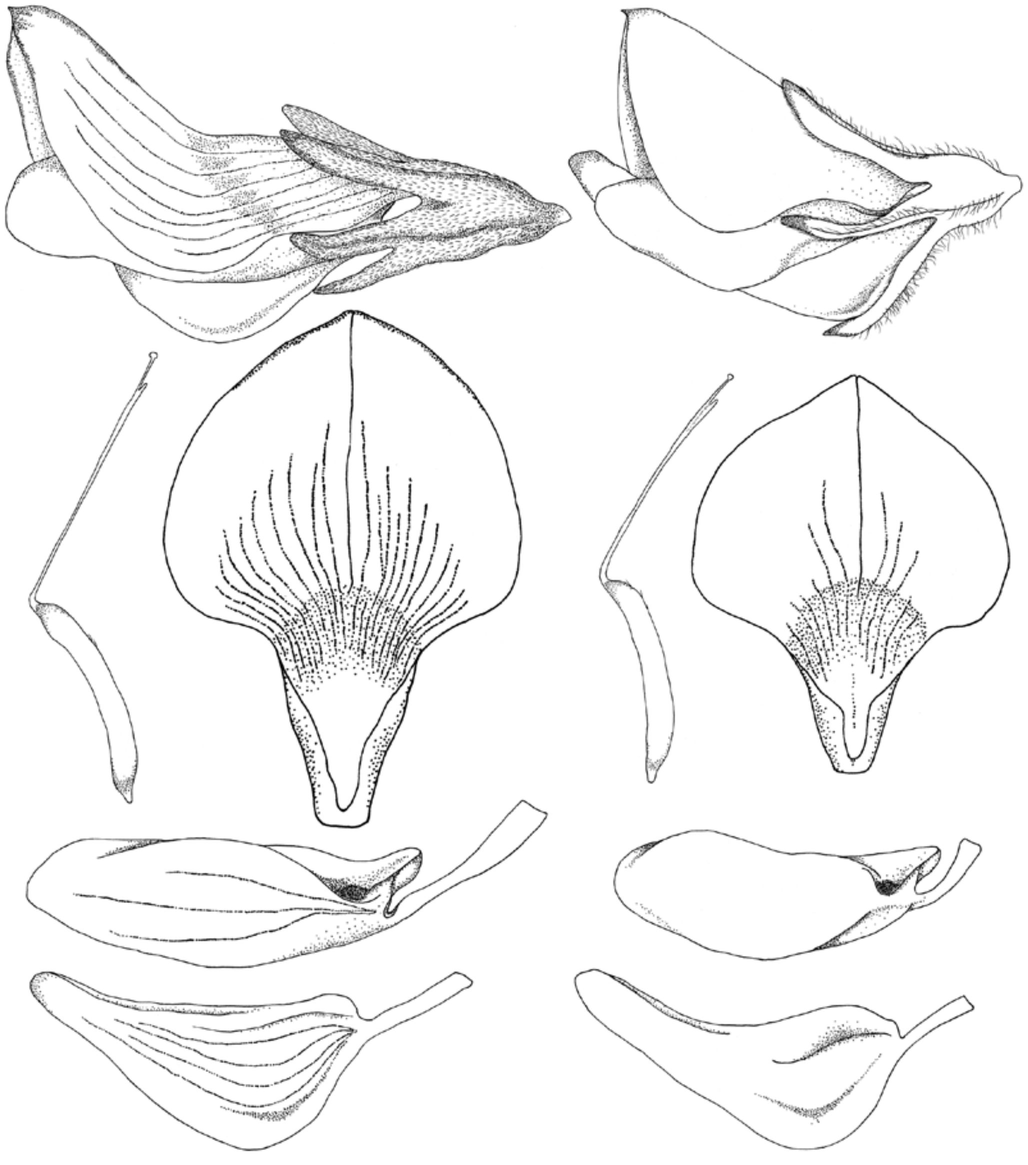

Figure 25: Flower morphology (magnification 5:1). Left, *Lotus emeroides* (*Sandral et al. 04-S17-17-SS*); right, *Lotus callis-viridis* (*Sandral et al. SA-40279*).

17832, Vallehermoso, 100 m, 27 Mar. 1975 [G]; *Lowe 127.9*, Hermigua, 18 Apr. 1861 [LE]; *Murray s.n.,* Hermigua, 25 May 1894 [K]; *Murray s.n.,* in the upper part of the Degollada de S. Sebastiano, 25 May 1894 [K]; *Nydegger 25162,* San Sebastian – Hermigua, 12 km W San Sebastian vor Tunnel, 600 m, 7 Jan 1988 [M]; *Ragov 962101003,* Valle de Hermigua, 9 Apr. 1996 [K]; *Sandral et al. SA-40306*, 28°11.457' N, 17°12.181' W, 351 m, 19 Jul. 2003 (seeds), cultivated in Perth (plot 310) and pressed in 2005 [MW]; *Sandral et al. SA-40304* and *SA-40305*, 28°11.457' N, 17°12.181' W, 351 m, 18 Jul. 2003 (seeds), cultivated in Perth (plots 339 and 364) and pressed in 2006 [K, MW], cultivated in Adelaide from seeds collected in Perth (as *SA-43900*) and pressed in 2006 [K, MW]; *Sandral et al. 04-S17-17-SS*, 28°11.089' N, 17°14.951' W, 340 m, 17 Jul. 2004 (seeds), cultivated in Perth (plot 351) and pressed in 2005 and 2006 [K, MW]; *Sventenius s.n.,* Pico de Aragán, 19 May 1965 [ORT].

(24) ***Lotus callis-viridis*** Bramwell & D.H. Davis, Cuad. Bot. Canaria **16**: 51 (1972). – Holotype: *Bramwell & Humphries 3156,* Gran Canaria, Andén Verde, Los Herreros, Paso del Herrero, ca. 50 m, 28 Mar. 1971 [RNG!].

Illustrations: figures 18 H, 21 E, 22 F, 23 F, 25 (right).

Perennial herb, sometimes suffrutescent with prostrate to upright much branched shoots. Avdentitios roots on shoots absent. Shoot innovation mainly from serial bud complexes on shoots of the previous growth season. Leaves shorter or slightly longer than internodes, sessile, with five leaflets. Stipules not detectable. Leaflets on petiolules around 0.3–0.6 mm long. Leaf rachis slightly flattened, 0.6–0.8 mm wide, 2–6 mm long, slightly shorter to slightly longer than basal leaflets. Basal leaflets 1.5–6 mm long, with maximum width in the middle of the leaflet, slightly below or slightly above it, almost orbicular to elliptic, broadly ovate or broadly obovate, typically equally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 3–9 mm long, with maximum width typically in the upper of a leaflet, (broadly) obovate. Stem and leaves with curved and more or less spreading hairs up to 0.6 mm long. Stem and leaf indumentum not dense, with organ surface visible between hairs. Hairs are slightly denser on abaxial than adaxial leaflet surface. Shoots with a proximal portion bearing axillary shoots more or less repeating architecture of main shoot, then a portion bearing axillary umbels (in our material this zone includes just few nodes), and then again a zone with axillary repeating shoots; it is unknown if this distal zone may continue growth during the next season. Umbel peduncles 1.5–6 times longer than their subtending leaves. Sterile bract shorter than the calyx, with 3 equal or unequal leaflets. Umbels 1–4(5)-flowered. Flower-subtending bracts not detectable. Pedicels 2–3 mm long. Calyx 7–9 mm long, monosymmetric, but not or only slightly two-lipped. Calyx teeth about two times longer than the tube or even longer. Upper teeth slightly longer and broader than lower ones. Corolla yellow (but the standard may be with some red strips on the inner side at the base of the blade). All petals glabrous. Standard about as long as the keel. Wings 10–12 mm long, slightly shorter than or as long as the keel, 3–4.5 mm wide, not adhering together in their distal parts. Keel 10.5–13 mm long, tip straight. Stylodium 6–6.5 mm long, tooth always present, glabrous, up to 0.3 mm long. Ovary and fruit with very few hairs along the ventral suture, otherwise glabrous, sometimes fruits and ovaries entirely glabrous.

Selected examined specimens: **Canary Islands** (Spain): Gran Canaria: *Bramwell 3105*, Andén Verde – Aldea de San Nicolas road, Mar. 1971 (seeds), cult. in Jard. Canar. [RNG]; *Bramwell & Humphries 3156,* Andén Verde, Los Herreros, Paso del Herrero, ca. 50 m, 28 Mar. 1971 [RNG]; *Kunkel 14746*, Andén Verde, 400 m, 29 Mar. 1971 [G]; *Sandral et al. 04-S10-10-SS*, 28°01.850' N, 15°45.939' W, 546 m, 15 Jul. 2004 (seeds), cultivated in Perth (plot 209) and pressed in 2006 [K, MW]; *Sandral et al. SA-40279*, 28°01.423' N, 15°46.370' W, 438 m, 23 Jul. 2003 (seeds), cultivated in Perth (plot 250) and pressed in 2005 and 2006 [K, MW]; Tenerife: *Asplund 565*, Buenavista, between Casablanca and Teno, 500 m, 27 Mar. 1933 [K].

(25) ***Lotus purpureus*** Webb in Hooker, Icon. Pl. **8**: tab. 757 (1848). – Lectotype (Brochmann et al. 1997, Sommerfeltia **24**: 225): *Forbes s.n.*, Cap Verd. [G-BOISS!, isolectotype K!].

= *Lotus bollei* Christ, 1888, Bot. Jahrb. Syst. **9**: 123. – Lectotype (designated here): *Bolle s.n.,* St. Vincent, M^{te} Verde, 30 Oct. 1852 [K!, isolectotype Z!].

= *Lotus candidissimus* A. Chev., Rev. Bot. Appl. Agric. Trop. **15**: 965 (1935). – Holotype: *Nobre s.n.*, Sto. Antão, Covão, 500–900 m, Jun. 1935 [P].

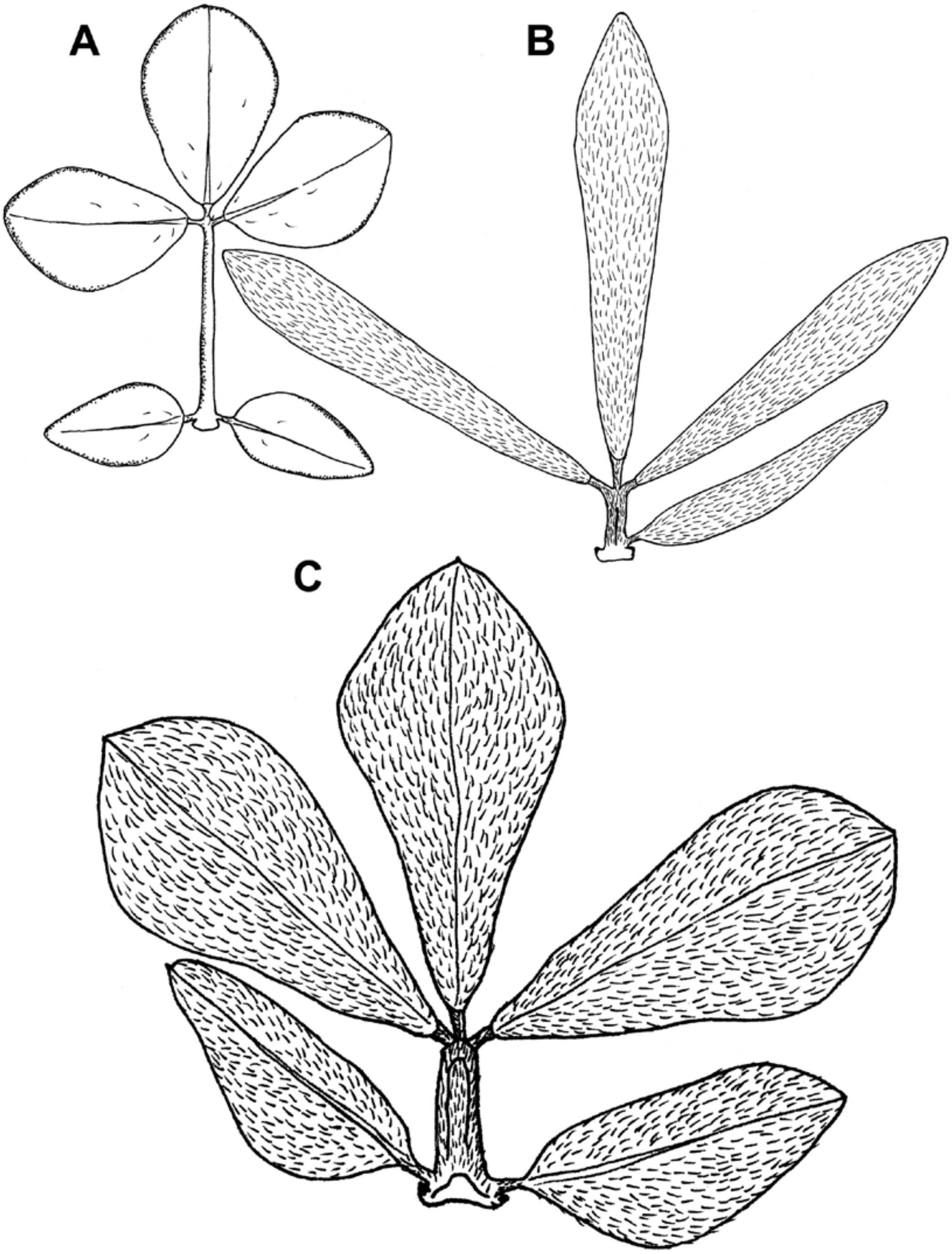

Figure 26: Leaf morphology (magnification 5:1). A, *Lotus purpureus* (*SA-39011*); B, *Lotus brunneri* (*Sandral et al. SA-40291*); C, *Lotus latifolius* (*Sandral et al. SA-40343*).

= *Lotus coronillaefolius* Webb in Hooker, Niger Fl.: 119 (1849), non Guss. (1832). – Holotype: “Capvert. Herbier ... St. Hilaire” [P].

= *Lotus hirtulus* Lowe ex Cout., Arq. Univ. Lisboa **1**: 289 (1914); Lobin, Cour. Forsch.-Inst.

Senckenberg **81**: 125 (1986). – Lectotype (designated by Chevalier 1935, Rev. Bot. Appl. Agric. Trop. **15**: 967): *Lowe*, Sto. Antão, Ribera Grande [P].

Illustrations: figures 21 F, 23 G, 26 A.

Perennial herb or half-shrub. Leaves shorter or longer than stem internodes, pinnate, with five leaflets. Petiole, if present, up to 0.8 mm long. Stipules usually present as black dark glands 0.1–0.2 mm. Leaflets on petiolules up to 0.6(1) mm long. Leaf rachis 2–8 mm long, longer than (up to twice longer) to slightly shorter than basal leaflets. Basal leaflets 1–5 mm long, with maximum width in the middle of the leaflet, slightly below or slightly above it, elliptic, orbicular, ovate, or almost obovate, usually equally sided. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 3–9 mm long, with maximum width in the upper part of a leaflet, elliptic, orbicular, obovate to almost triangular, sometimes emarginate. Stem and leaves with short straight or patent hairs, their density vary considerably from specimen to specimen. Umbel peduncles 1.5–5 times longer than their subtending leaves. Sterile bract shorter than the calyx, usually with 3 leaflets and shortened rachis. Umbels 1–2(4)-flowered. Flower subtending bracts are visible at the base of pedicels as very small scales with dark glandular tissue along the upper part of internal side, up to 0.3 mm long. Calyx 5–7.5(8) mm long, monosymmetric and only slightly two-lipped; upper teeth shorter than or as long as the tube, wider and longer than lower teeth; lower teeth shorter than the tube. Corolla yellow but darkens to orange with age, 10–15(–16) mm long. All petals glabrous. Wings usually shorter than other petals, adhering or not adhering together in their distal parts. Keel tip usually with a dark tip and incurved inwards. Stylodium 6–7 mm long, tooth always present, glabrous, up to 0.2–0.5 mm long. Ovary and fruit with hairs along the ventral suture only. Fruit straight, not or slightly constricted between seeds, 2–5 times longer than the calyx.

Selected examined specimens: **Cape Verde**, Boa Vista: *Cardoso de Matos 6429*, Rabil, Tapada de Pedro Santos, 43 m, 13 Apr. 1988 [MA]; Brava: *Lowe s.n.,* 3000 ft, 28 Mar. 1864 [K]; *Lowe s.n.*, 24 Mar. 1864 [LE]; *Lowe s.n.*, seacliff at the landing place, 26 Mar. 1864 [BM]; *Hance 6596*, Brava, Mar. 1864 [BM]; São Nicolau: *Bolle s.n.* [Z]; *Forbes s.n.* [G-BOISS, K]; São Vicente: *Bolle s.n.*, M^te^ Verde, 30 Oct. 1852 [K, Z]; *Chevalier 45813,* Mt. Verde, 7 Sep. 1934 [K]; *Dinklage 3154*, Mt. Verde, 600 m, 17 Oct. 1934 [K]; *Lowe s.n.*, 1–300 ft., 14–16 Feb. 1864 [LE]; *Lowe s.n.*, Mar. 1866 [K]; *Lowe s.n.*, rocky hill or peak near Mr. Miller's country house, 12 or 1500 ft, 15 Feb. 1864 [BM]; *Moseley s.n.*, recd. Nov. 1873 [K]. – Also in Santo Antão, Fogo and Santiago (Brochmann et al. 1997).

(26) ***Lotus brunneri*** Webb in Hooker, Icon. Pl. **8**: tab. 754 (1848). – Holotype: *Brunner s.n.,* "in insulae Salis lapidosis magna copia" [K-000262733!, isotypes K-000262732! and LE!].

Illustrations: figures 21 G, 22 H–I, 23 J, 26 B, 27 (right).

Perennial herb or more often half-shrub with typically prostrate shoots. In cultivated material perennial branches were always prostrate. Adventitious roots on shoots absent. Leaves usually shorter than stem internodes, almost sessile or with short petioles up to 0.8 mm long, with small glandular dark stipules, and with 3–5 leaflets. The fraction of leaves with different leaflet number varies from individual to individual and from accession to accession. Some individuals with almost exclusively trifoliolate leaves (plus very few 4-foliolate leaves). Some other individuals possess mostly 5-foliolate and 4-foliolate and only few 3-foliolate leaves. Trifoliolate leaves appear to be petiolate but, in fact, basal leaflet pair is just suppressed and their very small rudiments can

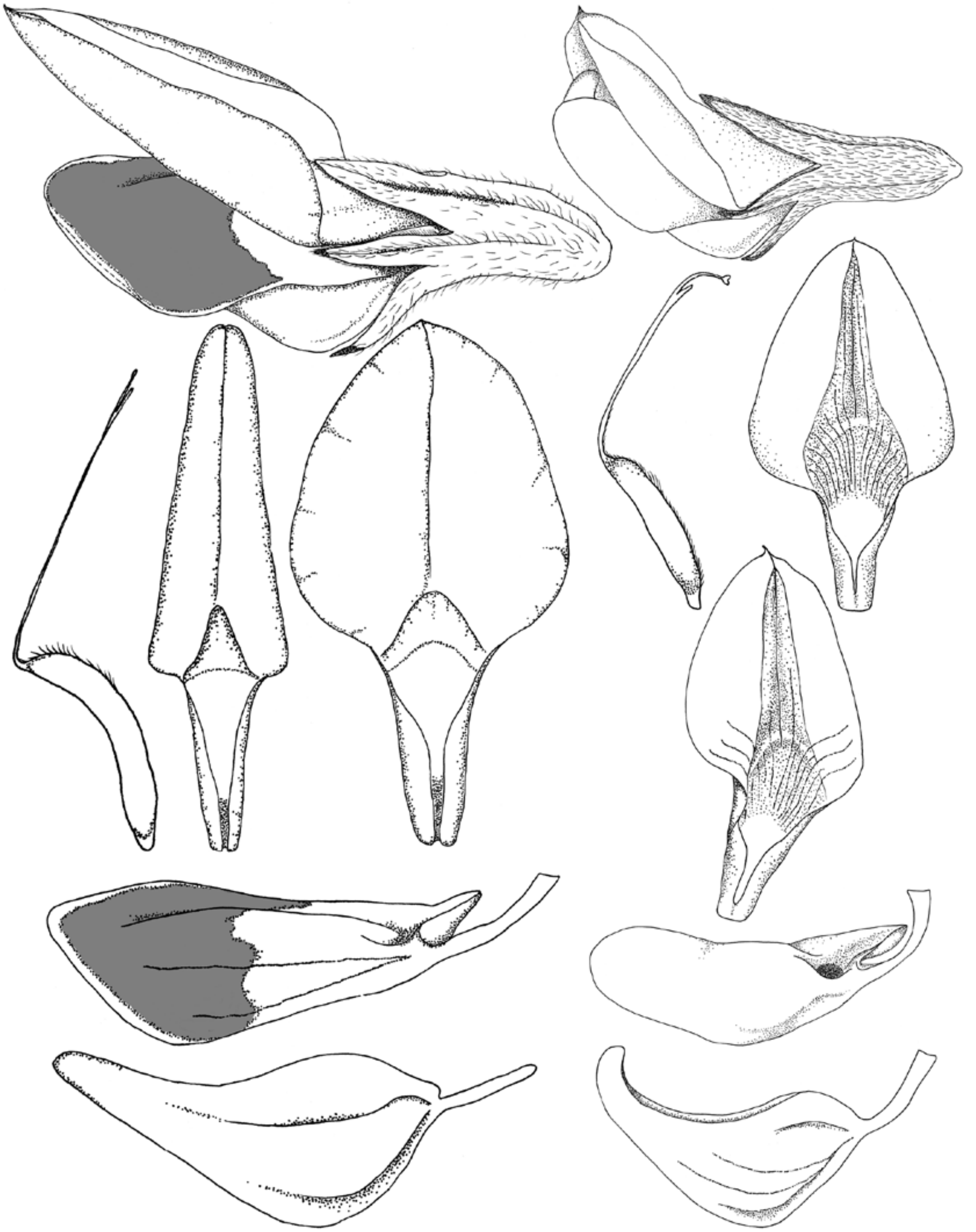

Figure 27: Flower morphology (magnification 5:1). Left, *Lotus latifolius* (*Sandral et al.03-S80-246-S*); right, *Lotus brunneri* (*Sandral et al. SA-40291*).

be sometimes traced; thus, what appears to be a petiole, is in fact a rachis. Leaflets with petiolules up to 1.4 mm long. Leaf rachis slightly if at all flattened, canaliculate above, around 0.6 mm wide, 0.7–9 mm long. Basal leaflets, if present, up to 15 mm long but usually shorter, linear to broadly elliptic, equally sided, with maximum width near the middle of a leaflet or sometimes in its lower or upper part. All three distal leaflets attached to the top of the rachis or sometimes one leaflet attached slightly below the top. Distal leaflets are longer than or rarely as long as basal leaflets, 6–21 mm long, with maximum width in the upper or middle part of a leaflet, linear-oblanceolate or very narrowly elliptic to oblanceolate, rarely obovate. Stem and leaves with short straight appressed hairs, with stem and leaf surface well visible between hairs. Shoots with a proximal zone with nodes bearing paracladia and a distal zone bearing numerous nodes with axillary umbels. Additional axillary buds in both zones of main shoot give rise paracladia or innovation shoots. Umbel peduncles 1.5–3.5 times longer than their subtending leaves. Sterile bract longer than, as long as, rarely shorter than the calyx, with shortened rachis and typically three leaflets (the middle leaflet usually longer than lateral ones). Umbels 1–7-flowered. Flower-subtending bracts present, as wide as pedicel width and about 0.1 mm long, brownish-red, hairy. Pedicels 1–2 mm long. Calyx 6–7 mm long, monosymmetric, but not two-lipped. All teeth are of about the same length (lateral lower teeth slightly shorter), as long as the tube to much shorter than the tube. Calyx tube and teeth outside with slightly curved almost appressed hairs; teeth also with some straight appressed hairs inside. Anthetic petals yellow. Postanthetic petals often brownish. All petals glabrous. Standard usually longer than the keel; standard margins are only slightly folded backwards at anthesis,. Wings 10–13 mm long, slightly longer than or as long as the keel, 2.5–4 mm wide, not adhering together in their distal parts. Keel 10–12 mm long, tip usually incurved. Stylodium 5–6 mm long, tooth always present, glabrous, 0.2–0.6 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, 3–6 times longer than the calyx.

Selected examined specimens: **Cape Verde**: Boa Vista: *Chevalier 44360*, 7–9 Jul. 1934 [K]; *Cardoso de Matos 6400*, Morro Amadorinho, 40 m, 10 Apr. 1988 [MA]; *Sandral et al. SA-40297*, 16°10.512' N, 22°55.720' W, 18 m, 1 Aug. 2003 (seeds), cultivated in Perth (plot 203) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40298*, 16°01.568' N, 22°57.440' W, 13 m, 3 Aug. 2003 (seeds), cultivated in Perth (plot 388) and pressed in 2005 and 2006 [K, MW], cultivated in Adelaide from seeds collected in Perth (as *SA-43892*) and pressed in 2006 [K, MW]; Maio: *Cardoso de Matos 6152*, Lage Branca, 6 m, 29 Apr. 1987 [MA]; *Cardoso de Matos 6157*, Lage Branca, 6 m, 29 Apr. 1987 [MA]; *Cardoso de Matos 6346*, Terras Salgadas, 5 m, 13 Jan. 1988 [MA]; *Malato-Beliz & Guerra 11*, Porto Ingles, 7 Nov. 1964 [K, MA]; *Malato-Beliz & Guerra 126*, Dunas do Morrinho, 8 Nov. 1964 [K, MA]; *Malato-Beliz & Guerra 170*, Monte de St. António, 9 Nov. 1964 [K, MA]; *Malato-Beliz & Guerra 178*, Lagoa, 9 Nov. 1964 [MA]; *Malato-Beliz & Guerra 204*, Toril, 10 Nov. 1964 [MA]; *Malato-Beliz & Guerra 44*, Porto Ingles, 7 Nov. 1964 [K, MA]; Sal: *Brunner s.n.* [K, LE]; *Sandral et al. SA-40290*, 16°45.313' N, 22°55.363' W, 31 m, 27 Jul. 2003 (seeds), cultivated in Perth (plot 219) and pressed in 2005 [MW]; *Sandral et al. SA-40291*, 16°44.240 N, 22°56.348' W, 65 m, 28 Jul. 2003 (seeds), cultivated in Perth (plot 346) and pressed in 2005 and 2006 [K, MW]. – Brochmann et al. (1997) cited also an old specimen from São Vicente and noted absence on new collections.

(27) *Lotus latifolius* Brand, Bot. Jahrb. Syst. **25**: 202 (1898). – Holotype: *Bolle*, 1853, S. Antoine [G-BOISS].

= *Lotus oliveirae* A. Chev., Rev. Bot. Appl. Agric. Trop. **15**: 966 (1935). – Holotype: *Chevalier 45585*, Sto. Antão, Cova, 1350 m, sur les contreforts du volcan, 1934 [P].

Illustrations: figures 21 H–I, 22 J, 23 G–I, 26 C, 27 (left).

Half-shrub with prostrate or less often ascending shoots. Adventitious roots on shoots absent. Leaves shorter than or longer than stem internodes, almost sessile or with short petioles up to

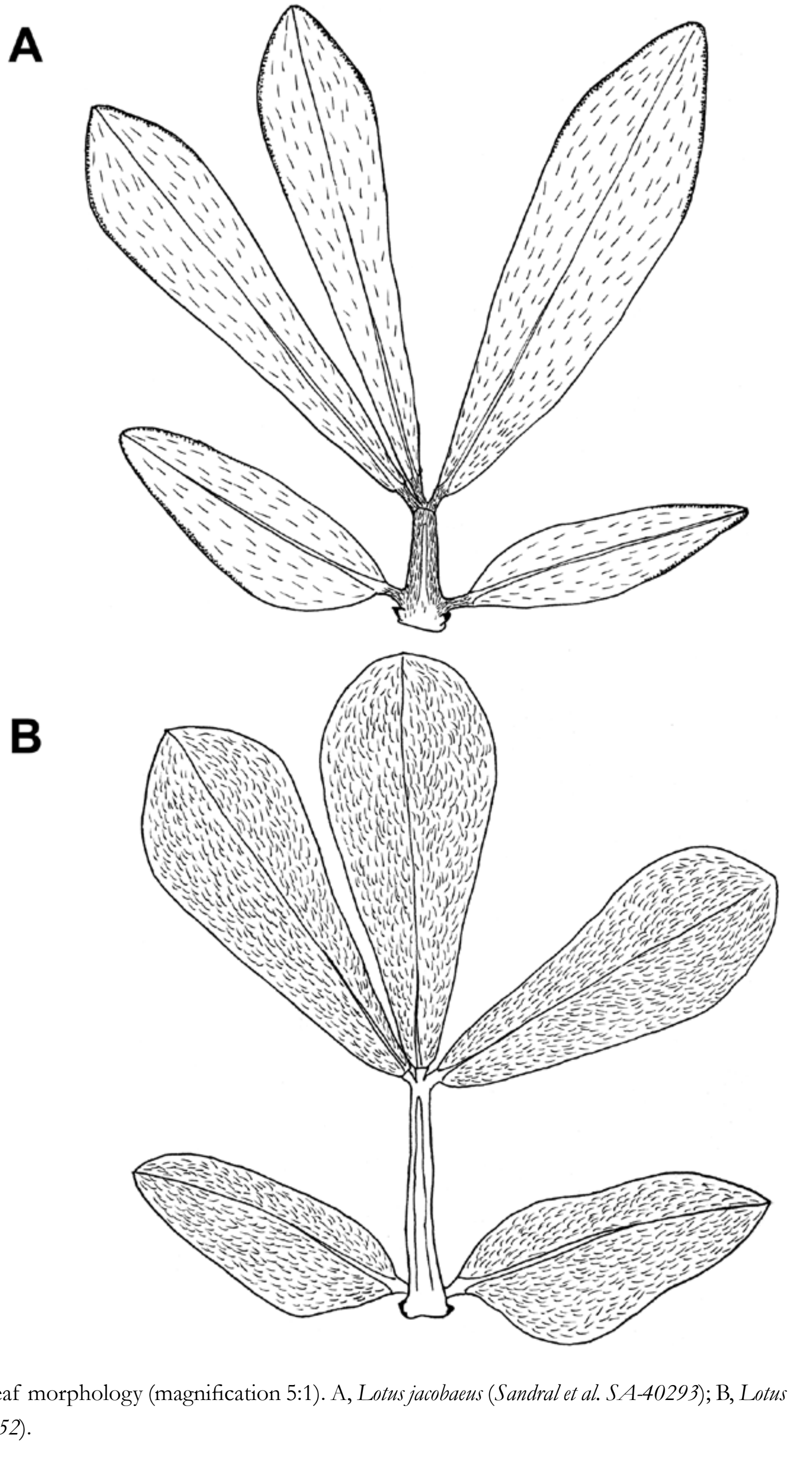

Figure 28: Leaf morphology (magnification 5:1). A, *Lotus jacobaeus* (*Sandral et al. SA-40293*); B, *Lotus arborescens* (*Sandral et al. SA-40352*).

1 mm long, pinnate, with five leaflets. Stipules usually present as small dark structures 0.1–0.2 mm long and 0.1–0.2 mm wide. Leaflets with petiolules up to 1.2 mm long. Leaf rachis slightly flattened, 0.8–1.1 mm wide, (1)3–9 mm long, usually sorter than, rarely as long as the basal leaflets. Basal leaflets 3–19 mm long, narrowly lanceolate to narrowly ovate or narrowly elliptic or elliptic,

equally or slightly unequally sided. At least some basal leaflets on a plant with maximum width in the lower part of a leaflet. All three distal leaflets attached to the top of the rachis. They are longer than or rarely as long as basal leaflets, 6–25 mm long, with maximum width usually in the upper part of a leaflet, very narrowly elliptic or narrowly oblanceolate to elliptic or narrowly obovate. Stem and leaves with straight or almost straight hairs those are either appressed or patent. Stem and leaf surface visible or not visible between hairs. In young plants, shoots comprise a basal zone with nodes bearing paracladia and a distal zone with nodes bearing axillary umbels. Additional axillary buds in both zones of main shoot give rise paracladia or innovation shoots. In older plants branching system is more complex, and the main shoot continues growth after formation of a zone of axillary umbels. Umbel peduncles (1.5)2–2.5(3) times longer than their subtending leaves. Sterile bract usually longer than or as long as, rarely shorter than the calyx, most often with shortened rachis and three leaflets, and with middle leaflet longer than lateral ones. Umbels (1–)3–6-flowered. Flower-subtending bracts usually present, 0.3–0.8 mm wide and 0.1–0.2 mm long, brownish-red, hairy. Pedicels 1–2 mm long. Calyx 8–11 mm long, monosymmetric, only slightly or not two-lipped. Teeth of about the same length, as long as the tube or slightly shorter than the tube, two upper teeth wider than three lower teeth. Indumentum, similar to that on stem and leaves, is present on outer side of the calyx; teeth also with straight hairs inside. Anthetic petals entirely yellow or yellow with brown areas at distal parts of wings, sometimes also with brown strips and brownish areas on outer surface of the standard, keel sometimes with small brown area near the tip. Postanthetic petals brown. All petals glabrous. Standard usually longer than the keel, standard margins are typically folded backwards at anthesis. Wings 15–18 mm long, slightly longer than the keel, 3.5–4 mm wide, usually adhering together in their distal parts. Keel 14–17 mm long, tip straight. Stylodium 6–7.5 mm long, tooth always present, glabrous, 0.5–1 mm long. Ovary and fruit with hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, (1.5)2–3.5 times longer than the calyx.

Examined specimens: **Cape Verde**: Santo Antão: *Sandral et al. 03-S77-238-S* and *SA-40343*, 17°06.267’ N, 25°02.982’ W, 1348 m, 31 Jul. 2003 (seeds), cultivated in Perth (plots 365 and 381) and pressed in 2006 [K, MW]; *Sandral et al. 03-S78-239-S* and *SA-40345*, 17°05.813’ N, 25°02.819’ W, 1189 m, 31 Jul. 2003 (seeds), cultivated in Perth (plots 223 and 336) and pressed in 2005 and 2006 [K, MW], cultivated in Adelaide from seeds collected in Perth (as *SA-43896)* and pressed in 2006 [K, MW]; *Sandral et al. 03-S79-242-S*, 17°04.801’ N, 25°03.765’ W, 783 m, 31 Jul. 2003 (seeds), cultivated in Perth (plot 324) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. 03-S80-246-S*, 17°11.995’ N, 25°11.260’ W, 584 m, 31 Jul. 2003 (seeds), cultivated in Perth (plot 292) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. 03-S81-250-S*, 17°04.383’ N, 25°11.943’ W, 907 m. 31 Jul. 2003 (seeds), cultivated in Perth (plot 271) and pressed in 2006 [K, MW].

(28) ***Lotus arborescens*** Lowe ex Cout., Arq. Univ. Lisboa **1**: 289 (1914). – Lectotype (designated by Lobin 1986, Cour. Forsch.-Inst. Senckenberg **81**: 126): *Lowe s.n.*, Ins. S. Nicolai, 22 Feb. 1864 [LISU; isolectotypes P, BM-000056591 and K-000262737!].

= *Lotus purpureus* auct., non Webb (1848): Lobin, Cour. Forsch.-Inst. Senckenberg **81**: 126 (1986).

Illustrations: figures 21 L, 22 L, 23 K–L, 28 B, 29 (left).

Half-shrub or small shrub, with prostrate or erect shoots. Adventitious roots on shoots absent. Leaves shorter than or longer than stem internodes, sessile, pinnate, with five leaflets. Stipules

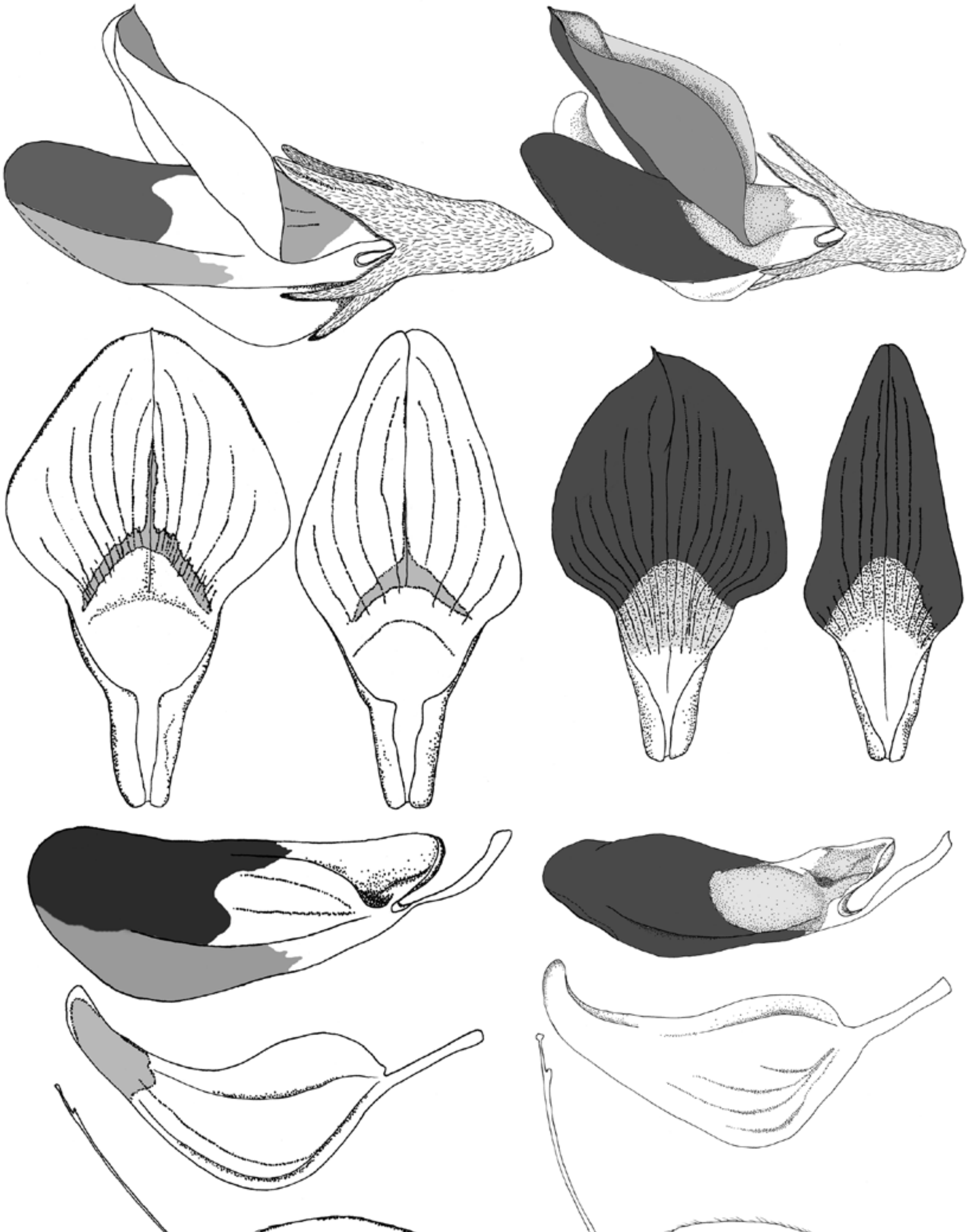

Figure captions Figure 29: Flower morphology (magnification 5:1). Left, *Lotus arborescens* (*Sandral et al. SA-40349*); right, *Lotus jacobaeus* (*Sandral et al. SA-40293*).

usually present as small dark structures around 0.1 × 0.1 mm. Leaflets with petiolules 0.4–1 mm long. Leaf rachis canaliculate on the upper side, 0.5–0.7 mm wide, 2–9 mm long, usually shorter than basal leaflets but longer than half of the length of basal leaflets. Basal leaflets 2–16 mm long, equally sided, most often elliptical, i.e. with maximum width in the middle part of a leaflet, less frequently the maximum width is in the lower or in the upper part of a leaflet. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 6–25 mm long, with maximum width usually in the upper part of a leaflet, oblanceolate to obovate. Stem and leaves with straight appressed or patent hairs. Stem and leaf surface visible between hairs. Shoots comprise a basal zone with nodes bearing paracladia and a distal zone with nodes bearing axillary umbels (sometimes one or few paracladia, instead of umbels, develop from main buds of serial complexes also in the distal part of main shoot). Additional axillary buds in both zones of main shoot give rise paracladia or innovation shoots. Usually, most umbel peduncles on a plant are either shorter than or as long as their subtending leaves. However, usually there are few peduncles on a plant that are 1–3-times longer than their subtending leaves. Sterile bract shorter than to longer than the calyx, with shortened rachis and 1–3 leaflets. Umbels 1–5-flowered. Flower subtending bracts brownish-red, glandular, form a tiny disrupted ring at the top of the peduncle; or flower-subtending bracts distinct from each other; or each bract is represented by two or three very small brownish-red structures. Pedicels 1–2 mm long. Calyx (7)8–10 mm long, monosymmetric, prominently two-lipped or almost not so. Teeth of about the same length (or upper ones slightly longer), as long as the tube or slightly shorter than the tube, two upper teeth wider than three lower teeth. Calyx tube and teeth with straight appressed or patent hairs; presence or absence of appressed hairs on the inner surface of teeth is variable. Anthetic petals either all entirely light-yellow; or mostly light-yellow, but keel brownish near the tip and wings with brownish-purple area in the upper-distal part and sometimes light brownish-purple in lower-distal part; or, in addition to brown areas on the keel and on the wings, the standard is also brownish outside. Postanthetic petals brownish. All petals glabrous. Standard longer than or as long as the keel, standard margins are typically folded backwards at anthesis. Wings 12–15 mm long, longer than the keel, 4–5 mm wide, usually adhering together in their distal parts. Keel 11–14 mm long, tip incurved or almost straight. Stylodium 5.5–7 mm long, tooth always present, glabrous, 0.1–0.4 mm long. Ovary completely glabrous or with few hairs along the ventral suture. Fruit straight, not or slightly constricted between seeds, 2.5–5 times longer than the calyx.

Selected examined specimens: **Cape Verde**: São Nicolau: *Lowe s.n.*, mountain pastures, 22 Feb. 1864 [K]; *Sandral et al. SA-40348* and *SA-40349,* 16°36.932' N, 24°19.755' W, 710 m, 4 Aug. 2003 (seeds), cultivated in Perth (plots 269 and 357) and pressed in 2006 [K, MW]; *Sandral et al. SA-40350* and *SA-40351*, 16°36.572' N, 24°19.465' W, 677 m, 4 Aug. 2003 (seeds), cultivated in Perth (plots 308 and 366) and pressed in 2006 [K, MW]; *Sandral et al. SA-40352*, 16°36.776' N, 24°21.090' W, 855 m, 4 Aug. 2003 (seeds), cultivated in Perth (plot 202) and pressed in 2006 [K, MW], cultivated in Adelaide from seeds collected in Perth (as *SA-43904*) and pressed in 2006 [K, MW]; *Sandral et al. SA-40354*, 16°36.561' N, 24°19.287' W, 623 m, 5 Aug. 2003 (seeds), cultivated in Perth (plot 362) and pressed in 2005 and 2006 [K, MW].

(29) ***Lotus jacobaeus*** L., Sp. Pl.: 775 (1753). – Lectotype (designated by Wijnands 1983, The botany of the Commelins: 165): Herb. Clifford No. 372.7 [BM-000646728!].

= *Lotus anthylloides* Vent., Jard. Malmaison: tab. 92 (1805). – Holotype: Cult. in Jardin de la Malmaison [W!].

= *Lotus melilotoides* Webb in Hooker, Niger Fl.: 118 (1849). – Holotype: "Capvert. Herbier ... St. Hilaire" [P].

= *Lotus atropurpureus* DC., Cat. Pl. Horti Monsp.: 121 (1813). – Holotype: Cult. in Bot. Gard. Genève [G-DC].

Illustrations: figures 21 J–K, 22 K, 23 M–O, 28 A, 29 (right).

Half-shrub or small shrub, with more or less erect, rarely prostrate shoots. Adventitious roots on shoots absent. Leaves often longer than (but sometimes shorter than) stem internodes, almost sessile, pinnate or less often palmate, usually with five leaflets. Stipules usually present as small dark structures 0.1–0.4 mm wide and 0.1–0.2 mm long. Leaflets with petiolules up to 0.6–1.3 mm long. Leaf rachis, if present, only slightly flattened, 0.5–0.9 mm wide, up to 6(7) mm long, less than 0.5 the length of the basal leaflets. Basal leaflets (3–)7–25 mm long, equally sided, typically with maximum width near the middle of a leaflet, linear, narrowly elliptical, elliptical, or rarely oblanceolate. All three distal leaflets attached to the top of the rachis. They are longer than basal leaflets, 6–25 mm long, with maximum width in the upper or in the middle part of a leaflet, very narrowly lanceolate or linear to narrowly obovate or elliptic. Stem and leaves with straight appressed or patent hairs. Stem and leaf surface visible between hairs. Shoots comprise a proximal zone with nodes bearing paracladia (or innovation shoots) and a distal zone with nodes bearing axillary umbels. Additional axillary buds in both zones of main shoot give rise paracladia or innovation shoots; some additional buds in the distal zone may give rise axillary umbels. Most umbel peduncles on a plant are either shorter than or as long as their subtending leaves. Sterile bract shorter than to longer than the calyx, with shortened rachis and (1–)3 usually unequal leaflets. Umbels 1–6-flowered. Flower subtending bracts brownish-red, glandular, form a tiny disrupted ring at the top of the peduncle; or flower-subtending bracts distinct from each other; or each bract is represented by two or three very small brownish-red structures. Pedicels 0.7–2 mm long. Calyx (5)8–11 mm long, monosymmetric, but not two-lipped. Teeth of about the same length (or upper ones slightly longer), as long as the tube or shorter than the tube, two upper teeth slightly wider than three lower teeth. Calyx tube and teeth with straight appressed or patent hairs; teeth also with appressed hairs on the inner surface (in their distal parts). Anthetic petals usually yellow with brownish-purple. In our cultivated material standard blade is brownish-purple inside and brownish-yellow outside, standard claw yellowish, wings are brownish-purple with a yellow spot at the base, and keel is yellow (or slightly brownish-yellow). Other colour combinations are also reported; sometimes petals are entirely yellow. Postanthetic petals brownish. All petals glabrous. Standard longer than or as long as the keel, standard margins are typically folded backwards at anthesis. Wings 11–15 mm long, longer than or as long as the keel, 3–4.5 mm wide, usually adhering together in their distal parts. Keel 10–14 mm long, tip usually incurved. Stylodium 5–7.5 mm long, tooth always present, glabrous, 0.05–0.4 mm long. Ovary with few hairs along the ventral suture, otherwise glabrous. Fruit straight, not or slightly constricted between seeds, (2)3–5 times longer than the calyx.

Selected examined specimens: **Cape Verde**, Fogo: *Newton s.n.*, 1000 to 1800 m, Oct. 1898 [K]; *Lowe 7*, road to Mosteiros, not below 2500 ft, 11 Feb. 1866 [LE]; *Lowe s.n.,* 7000 ft, 15 Feb. 1866 [K]; *Lowe s.n.*, 2000 ft, towards Mosteiros, 11 Feb. 1866 [K]; *Lowe s.n.*, road to Mosteiros, not below 2500 ft, 11 Feb. 1866 [BM, K]; *Lowe s.n.*, 24 Mar. 1864 [K]; *Lowe s.n.*, 18 Mar. 1864 [K]; Santiago: *Lowe s.n.*, Orgãos, 10 Mar. 1864 [LE]; *Sandral et al. SA-40293*, 15°12.598’ N, 23°42.334’ W, 439 m, 30 Jul. 2003 (seeds), cultivated in Perth (plot 251) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40294*, 15°10.492’ N, 23°41.283’ W, 844 m, 30 Jul. 2003 (seeds), cultivated in Perth (plot 390) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40295*, 15°05.227’ N, 23°39.470’ W, 588 m, 30 Jul. 2003 (seeds), cultivated in Perth (plot 354) and pressed in 2005 and 2006 [K, MW]; *Sandral et al. SA-40296*, 15°02.219' N, 23°34.317' W, 520 m, 31 Jul. 2003 (seeds), cultivated in Perth (plot 356) and pressed in 2005 and 2006 [K, MW].

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